NASA ECHO Project

ECHO Client Partner's Guide

July 2010

Document Version 10.10

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REVISION HISTORY

Date	Version	Brief Description	Author
11/1/07	10.1	Initial version for ECHO 10	Judith Wright
01/16/08	10.2	Incorporate ECHO Operations' comments	Judith Wright
04/22/08	10.3	Added instrumentShortName to query sections	Jason Gilman
05/22/08	10.4	Update query sections for Cartesian searching changes	Jason Gilman
6/02/08	10.5	Added option definition changes to order option sections	Lisa Pann
06/17/08	10.6	Added bounding box searching to query sections	Jason Gilman
07/01/08	10.6	Added additional information on instrument short name condition.	Jason Gilman
11/18/08	10.6	Added patternList definition and usage. Added links to DTDs. Removed references to global granule searching.	Doug Newman
12/18/08	10.8	Updated for catalog service api changes.	Jason Gilman
02/12/09	10.9	Updated for science keywords query change.	Jason Gilman
07/13/10	10.10	Removed reference to <orderable> element and added PII warning.	Matthew Cechini

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PREFACE

The *ECHO 10.10 Client Partner's Guide* document provides a look and guide to the operational 10.10 release of the Earth Observing System (EOS) Clearinghouse (ECHO) from the perspective of the Client Partner.

Release 10.10 of was a mixture of Ingest and Kernel (client) changes. While the primary focus was on a rewrite of Ingest, there were also changes made to ECHO itself. The Ingest changes include expanded data validation checks, which will increase the intergrity of metadata. The ECHO kernel changes included incorporating ECS, enhanced security measures, and the addition of multi-orbit search support.

The formatting of this document has been changed to make it easier to find and reference items and to increase the readability of this document both online and on paper. Changes include, but are not limited to:

- Numbering of sections for easier reference as well as making it easier to determine "where you are" in the document
- Elimination of colors and subtle font changes for section headers since colors and often fonts are not visible or obvious when printed in black and white. Additionally, colors, particularly blue, are difficult for some vision-impaired people to see or distinguish.
- Addition of bookmarks for major sections and topics for easier online navigation through the document

CONVENTIONS

All references to time are in Universal Time Coordinated (UTC).

Data Partners are also referred to as Data Providers.

Client Partners are also referred to as Client Developers.

Words in **bold** text are key words or concepts.

```
Programming examples use a fixed width font, have upper/lower lines
separating them from the rest of the text, and are in this color font.
```

```
Comments (denoted by // within examples)
```

Best practices or warnings appear in italicized, boxed text.

CHAPTER 1. BEFORE YOU BEGIN

The primary reason for designing the EOS ClearingHOuse (ECHO) was to increase access to Earth science data and services by providing a system with a machine-to-machine interface, that is, an Application Programming Interface (API).

ECHO functions as a metadata clearinghouse of Earth science metadata for a wide variety of partners, enabling the science community to exchange information. Data Partners provide the ECHO community with metadata representing their Earth science data holdings. ECHO technology in turn provides services for Client Partners and Data Partners and supports efficient discovery and access to Earth science data.

ECHO also functions as an order broker for the data, and offers services applied to that data. ECHO provides a portal on the internet where ECHO clients can search the metadata for information they wish to order.

Client applications can access data holdings via order distribution or online access. Data Partners retain complete control over what metadata are represented in ECHO including inserting new metadata, modifying existing metadata and removing old metadata, and controlling access to their metadata.

External Links?

1.1 Tasks That You Will Perform as a Client Partner

Usually performed in the order shown below:

• Logging in and getting started – Creating and managing ECHO sessions – Creating and managing user accounts	Chapter 3
• Querying for Earth Science Data – Formatting query results – Handling large result sets – Using subscriptions to automate queries » Creating and deleting subscriptions » Listing subscriptions	Chapter 4 Chapter 5 Chapter 6
• Ordering data through ECHO – Adding order items – Updating order items – Removing order items – Removing orders – Setting user information for an order – Validating orders – Requesting a quote for an order – Submitting an order – Tracking or canceling an order	Chapter 7

- Using Event Notification Service
  - Setting delivery modes
  - Filtering events
  - Creating event subscriptions
  - Removing event subscriptions
  - Renewing event subscriptions

Chapter 8

- Using Invocation Service
  - Invoking an operation
  - Getting results

Chapter 10

1.2 Skills You Will Need as a Client Partner

Since ECHO uses platform-independent web service definitions for its API, there are no requirements for a client programming language. All examples in this document are in snippets of Java code; however, the code samples provided could be translated to any web service capable language.

As an ECHO Data Partner, you need to be familiar with basic software development and Service Oriented Architecture (SOA) concepts such as:

- XML and XML Schema (XSD)
- Web Service Definition Language (WSDL)
- Service-based Application Programmer's Interface (API)
- Client/Server-based programming (client stubs, remote endpoints, etc.)

1.3 ECHO Concept and Design

NASA's Earth Science Data and Information System (ESDIS) has built ECHO based on Extensible Markup Language (XML) and Web Service technologies. ECHO interfaces with different clients and users through its series of Application Program Interfaces (APIs). ECHO is an open system with published APIs available to the ECHO Development and User community.

ECHO is a middleware application, and interacting with ECHO means interacting with the ECHO API. There is typically a user-focused client application interacting with ECHO's API on behalf of an end user. This client may be a generic, query and order-based client, or may be specific to an end user's research, mission, or general area of interest. ECHO incorporates a Universal Description, Discovery, and Integration (UDDI) registry to facilitate registration, discovery, and invocation of services related to the ECHO holdings.

Internally, ECHO specifies APIs and provides middleware components, including data and service search and access functions, in a layered architecture. The figure below depicts the ECHO system context in relation to its public APIs.

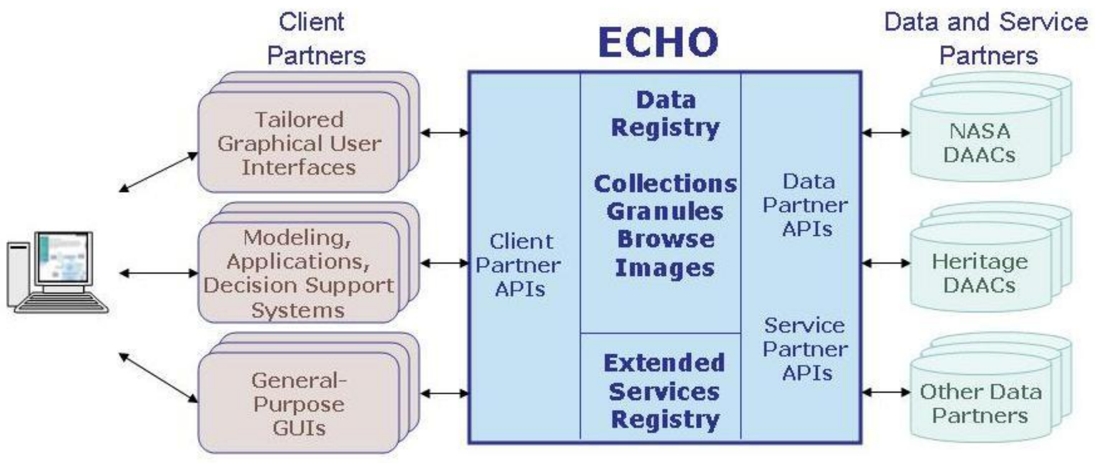


Figure 1. ECHO System Context

All ECHO metadata is stored in an Oracle database with spatial extensions. The metadata model is derived primarily from that used by the Earth Observing System Data and Information System (EOSDIS) Core System (ECS). For more details about the ECHO model, refer to ECHO Earth Science Metadata Model page of the ECHO website: http://www.echo.eos.nasa.gov/data_partners/data_model.shtml.

Key features of the ECHO architecture are:

- *Ease of Partner Participation* – Designed to be low-cost and minimally intrusive, ECHO offers a set of standard ways for partners to interface with the system and a metadata exchange approach that accommodates existing partners and technology.
- *Data Model Consistency* – To mitigate the risk of being unable to match all possible partner data models, ECHO has prototyped a Metadata Mapping Tool to translate non-standard formats upon ingest into ECHO.
- *Open System/Published APIs* – To accommodate independent ECHO clients, ECHO uses an open system approach and publishes domain APIs. These APIs are independent of the underlying transport protocols used. ECHO communicates using WS-I Basic Profile v1.0 compliant web services. This API is located on the Working with Web Services for ECHO on the ECHO website at: http://www.echo.nasa.gov/reference/reference.shtml.

Interactions with ECHO may involve user interactions in real time or may be machine to machine.

- *Evolutionary Development* – The ECHO system is being developed incrementally to allow for insight and feedback during the development cycle. Industry trends are followed and the use of commercial, off-the-shelf (COTS) products is optimized.
- *Extensibility of Client User Interfaces and Capabilities* – ECHO extensibility is ensured by its component architecture, which allows new capabilities and functions to be plugged in, modeling relationships between services/APIs/UIs, and continued prototyping. ECHO's current focus is on the middleware and on enabling many different types of user interfaces via its APIs.

1.3.1 ECHO as a Spatially Enabled Metadata Search and Order System

Oracle enables the ECHO system to interact with spatially enabled Earth science metadata by use of spatial extensions into the system and business logic within the system that understands how to interact with that metadata. In addition, a second ECHO interface (Ingest) allows metadata updates to go directly into the database, bypassing the message-passing API. The File Transfer Protocol (FTP) server is configured to receive these update files, which are expressed in XML conforming to three schemas, one for granules (or inventory), one for collections (or datasets), and one for browse.

Note: For ECHO 10.0 and later, these formats are schemas; for legacy ECHO, these formats are DTDs.

The schemas are defined on the ECHO 10.10 Ingest DTD/Schemas page of the ECHO website: http://www.echo.nasa.gov/reference/reference.shtml

Oracle's spatial capabilities support queries for ECHO metadata whose spatial extent is described within the system. A Data Partner can define the spatial extent of a granule or a collection with different spatial constructs (for example: point and polygon). A Client Partner can then construct a search using a point, a line, or a polygon (or multiple polygon) spatial type, and ECHO responds with data whose spatial region intersects the described region.

ECHO provides services for interacting with its **Catalog** of metadata. Queries can be performed in a number of ways; result formats can be specified, and the resulting data sets can be incrementally accessed so that large return sets can be handled gracefully. ECHO also supports constructing, submitting, and tracking orders for the data that the metadata represents. ECHO supports both an embedding of a Uniform Resource Locator (URL) within the metadata for accessing the data (which the client simply accesses via Hypertext Transfer Protocol [HTTP]), and a more complicated order process in which quotes and order options are accommodated.

ECHO incorporates the ECS concept of granules and collections and defines separate DTDs for updating each, under the assumption that granules will indicate which collection is considered their “primary” collection. “Primary collection” means the collection that owns the granule.

A **collection** is a grouping of granules that all come from the same source, such as a modeling group or institution. Collections have information that is common across all the granules they "own" and a template for describing additional attributes not already part of the metadata model.

A **granule** is the smallest aggregation of data that can be independently managed (described, inventoried, and retrieved). Granules have their own metadata model and support values associated with the additional attributes defined by the owning collection.

A third type of metadata, which is not spatially enabled but useful, is **browse metadata**, which provide a high-level view of granule or collection metadata and cross-referencing to other granules or collections.

1.3.2 Security

The ECHO system supports Secure Sockets Layer (SSL)-based communication, which a client must use to pass passwords or other sensitive information securely. Internally, the systems are firewalled to prevent unintended access.

1.3.3 Supported Platforms

The ECHO system supports clients capable of initiating an HTTP connection from a variety of programming languages.

1.3.4 ECHO as a Service Registry

The ECHO Extended Services Registry component is a public UDDI registry deployment. A UDDI registry enables organizations offering services to register and classify those services so that service consumers may discover them. For Web Services, a UDDI registry stores and provides information sufficient for service consumers to find the services offered by the partner and provides a central location for information publication and discovery. However, it does not participate directly in operations that may occur between consumers and partners.

There are standard programming interfaces (APIs) defined for all instances of UDDI registries. The standard UDDI interface comprises two distinct interfaces: the "Inquiry API" and the "Publishing API". The ECHO system makes the Inquiry API, which is used for discovering and retrieving information about registry content, available as a public interface. This interface describes a web service, which receives SOAP-formatted messages. In accordance with the UDDI specification, these messages "all behave synchronously and are required to be exposed via HTTPPOST only." You can find information about the UDDI Inquiry API at the following location: http://www.oasis-open.org/committees/uddi-spec/doc/tcspecs.htm#uddiv2

1.4 ECHO Capability and Functionality

ECHO provides an infrastructure that allows various communities to share tools, services, and metadata. As a metadata clearinghouse, it supports many data access paradigms such as navigation and discovery. As an order broker, ECHO forwards orders for data discovered through the metadata query process to the appropriate Data Partners for order fulfillment. As a service broker, ECHO decentralizes end user functionality and supports interoperability of distributed functions.

Although this Guide focuses on the needs of Client Partners, ECHO supports the following different, nonexclusive types of Partners:

- *Data Partners* – Organizations that supply metadata representing their data holdings to the ECHO database
- *Client Partners* – Organizations that participate by developing software applications to access the Earth science metadata in the ECHO database
- *Service Partners* – Organizations that participate by advertising their Earth science-related services to the user community via ECHO, which maintains service descriptions in a Service Catalog (either special services, or services that are available as an option on a selected set of granules/collections) and support the user in ordering those services.
- *Extended Service Partners* – Organizations that participate by providing a central location for registration, classification, and maintenance of Earth science services, interfaces, GUIs, and advertisements

ECHO addresses science user needs through a set of well-defined and open interfaces upon which the user community can build its own client applications. In this way, ECHO supports extendable, flexible user interfaces, allowing industry and the science community to drive the progress of available Earth science applications. For more complete information about client applications, refer to the companion piece to this Guide, the *ECHO 10.10 Data Partner's Guide*.

The ECHO approach allows users to build their own user interfaces to ECHO, rather than being limited to the data search and order system provided by NASA. For Data Partners, ECHO offloads the burden of providing the system resources required for searching and gives users the flexibility to support community-specific services and functionality. ECHO's interoperability features allow all participants to benefit from the distributed development of functions, again reducing dependence on NASA resources.

1.5 ECHO Benefits to Client Partners

To address the ECHO system vision, ECHO has responded to a set of system drivers, that is, reasons for upgrading. These drivers, derived from functional, organizational, and operational concerns expressed by the user community, determined the architectural approach and the types of technical solutions used in building the ECHO 10.10 system.

1.5.1 Ease of Participation

The primary goal of ECHO is to enable organizations to participate in making their resources and capabilities available to the Earth Science community. To facilitate participation by these organizations, ECHO has:

- Minimized the number of requirements that a partner must meet to participate
- Involved partners in the system's development cycle and requirements definition
- Selected metadata insert and update mechanisms based on current standard industry practice (for example, XML) that most databases can generate automatically
- Provided mapping capabilities to convert from one XML representation into another

1.5.2 Cost to Field

While aggressive in the capabilities it is targeted to support, ECHO minimizes the Cost to Field by continually evaluating performance and functionality against costs, for example, licensing of Commercial Off-the-Shelf

(COTS) applications, amount of custom code required, hardware platform requirements, and complexity of networking and installation.

1.5.3 Cost to Operate

Once fielded, ECHO seeks to minimize the cost to operate the system by making it easier to use, thereby minimizing the load on operations staff.

1.5.4 Extensibility

ECHO is being built with long-term extensibility foremost in mind. To enable emerging techniques and strategies for Earth Science research, ECHO has:

- Adopted a “design for change” as a goal at the beginning of ECHO development
- Built in the capability to limit the impact of changes to the API on the configuration file, the service interface, and the business logic that implement the function
- Developed test tools to regression test large portions of functionality automatically overnight, so that when changes are made, undesirable impacts can be discovered quickly
- Adopted a layered ECHO architecture to allow changes to one component of the system without affecting other components

1.6 ECHO Systems

There are three ECHO Systems that you, as a Client Partner, have access to:

a. **ECHO Operations.** This is the current operational system for ECHO and is available to all users.

   Location: http://api.echo.nasa.gov/echo/index.html

b. **ECHO Partner Test.** This is an operational system used only by the ECHO partners where they can test their data and services prior to making the final changes in the operational system

   Location: http://api-test.echo.nasa.gov/echo/index.html

c. **ECHO Testbed.** This is a test system area used by partners and ECHO testers to test before changes to the ECHO system go operational

Location: http://testbed.echo.nasa.gov/echo/index.html

CHAPTER 2. THE BASICS

One of ECHO's goals is to increase access to Earth Science data and services by providing a system with a machine-to-machine interface. For that reason, ECHO provides an Application Programming Interface (API). This section describes how to communicate with ECHO using its Web Services API.

ECHO is available in t

2.1 Locating the ECHO Web Services

To access a particular service through the ECHO Web Services API, refer to the Reference page of the ECHO website (http://www.echo.nasa.gov/reference/).

The table below shows each ECHO service and a brief description of its capabilities. The ECHO 9.0 Web Services API (no updates for ECHO 10.10) documentation describes in detail the services along with their operations and parameters, and is currently available online at: http://api.echo.nasa.gov/echo/ws/v9/index.html.

To access the Web Service Description Language (WSDL) document that describes a service, attach the suffix .wsdl from the API page following this format: http://api.echo.nasa.gov/echo-wsdl/v9/<Service Endpoint>.wsdl. Service Endpoints are found in Table 1.

Table 1. Description of Client Partner-Related ECHO Web Services

Service Name	Description	Service Endpoint
Administration	ECHO Operations housekeeping functions	AdministrationService
Authentication	Core user authentication capabilities—provides session management token services	AuthenticationService
Catalog	Data warehouse searching and exploration	CatalogService
Data Management	Data Partner service to support ECHO cataloged data	DataManagementService
Event Notification	User service to manage subscriptions to receive notifications of events from ECHO	EventNotificationService
Extended Services	Registration, classification and maintenance of Earth Science services, interfaces, GUIs, and advertisements	ExtendedServicesService
Group Management	Data Partner service to organize users into groups for data access control and notification	Group2ManagementService
Invocation	Simple service brokering capabilities that allow ECHO to execute external service requests asynchronously on behalf of users	InvocationService
Invocation Utility	Wrapper service to allow external Earth Science services to post status, execute asynchronously and return results to users	InvocationUtilityService
Order Management	Service to create and submit orders for users	OrderManagementService
Order Processing	Data Partner -oriented service to fill and apply a status to user orders	OrderProcessingService
Provider	Data Partner account creation and maintenance	ProviderService
Status	General status information of asynchronous user requests—currently only supported by the Invocation Service and Invocation Utility Service.	StatusService
Subscription	User service for creating data subscriptions so as to be notified when data is updated or modified	Subscription

Service Name	Description	Service Endpoint
Taxonomy	Management interface for data and service classification schemes used by ECHO, Data Partner and Client Partners	TaxonomyService
User	User account creation and maintenance	UserService

To see a detailed breakdown of functionality by user type and role type within ECHO, see Appendix B, Functional Breakdown By User/Role Type.

2.1.1 ECHO Error Handling

The ECHO 9.0/10.10 Web Service API has advanced error-reporting capabilities. Refer to Appendix E**,** ECHO Error Handling for a list of specific faults and their meanings.

2.2 Globally Unique Identifiers (GUIDS)

ECHO uses Globally Unique Identifiers (GUIDs) to uniquely identify objects within ECHO. Each GUID is a dd

is a mostly random number with a large number of unique keys that is assigned to each item by ECHO. A GUID is normally a 16-byte (128-bit) number in hexadecimal form.

ECHO uses GUIDs to identify items such as users, providers, contacts, orders, etc. Client applications use these GUIDs to find and operate on items using the ECHO API. Client applications should avoid displaying a GUID to the end user, as it is a machine-to-machine identifier. Most of the items in ECHO also accommodate a name preferred by the user; the client application can simply map from the item's user-displayed name to its actual GUID. This pairing of machine-readable GUID and human-readable name is referred to as a **NameGuid** in the ECHO API. You can retrieve a list of **NameGuids** for most items.

In almost all cases (with the notable exception of the Taxonomy API), the GUID on an item should be null when the item is sent to ECHO to be created. Once ECHO creates the item, it will generate a new GUID for the item and return it to the client.

Note: ECHO introduced the formalized ??? GUID pattern after the system had been under development for some years. Due to this, you may find that some GUIDs for ECHO objects (typically users and providers) do not follow the standard.

2.3 ECHO Entities

This section describes several high-level concepts that will help you understand the ECHO system. The following is a selected list of entities. For the complete list of ECHO entities, refer to the ECHO Data Model Entity List on the ECHO website at http://www.echo.nasa.gov/data_partners/ECHO3.shtml.

2.3.1 Users

The most basic entity in the ECHO system is a **user**. Each user is identified by a unique user name. There are two types of users: **registered users** and **guests**. Registered users can save information they plan to use in their next session. Guests have the ability to do many of the things registered users can do, but they cannot count on persistent access to information across sessions in addition to other limitations.

2.3.2 Roles

ECHO regulates access privileges based on the concept of user roles. User roles are a way to grant a user access to the system. These roles facilitate greater flexibility with operation-level authorization and allow certain users the ability to have more than one role without having more than one account in the system.

2.3.2.1 Provider Role

As a Client Partner, your role is the **provider role**. You may have one or more provider roles, each of which is associated with one provider in the ECHO system. Your provider roles allow you to access and update information about the providers with which they are associated. For example, if you have a provider role for Oak Ridge National Laboratory (ORNL), then you can use the UpdateProviders operation of the ProviderService to update the contact information for ORNL.

If you have more than one provider role, you must tell the system which provider you currently want to represent. This is the "provider context". The provider context indicates the current provider that you represent, and as the name implies, it is to this provider that the provider-oriented operations in the system are applied.

Note: If you are associated with only one provider role, the system assumes the provider associated with that one provider role is specified in the user's "provider context."

2.3.2.2 Administrator Role

A user can only be associated with one instance of this role. This role allows the user to access and update information about any user and any provider. Essentially, this role should allow the user full access to almost anything in the system and available through the current API. Users assigned this role should read the *ECHO 10.10 Operations Guide* as well as this document.

2.3.3 Queries

A **query** in the ECHO system is the term used for search and retrieval of science metadata stored by ECHO. You can search ECHO by calling the **ExecuteQuery** operation on the **CatalogService**—refer to Chapter 4, Querying for Earth Science Metadata for a detailed discussion of queries.

NOTE: You can search on collections (referred to as a "**Discovery Search**") or on granules (referred to as an "**Inventory Search**").

2.3.4 Results

ECHO automatically generates a **ResultSet** after an ECHO query. Every result set in ECHO has a unique identifier (that is, a GUID) within the system.

You can execute multiple queries simultaneously. Result sets from all these queries will be available by name (**ResultSetGUID**); however, result sets may be removed from ECHO without notice in a reasonable amount of time. Since guests are not allowed to save results in ECHO, the results are not available after the guest completes the ECHO session. Results can be retrieved by using the **GetQueryResults** operation in the **Catalog Service**.

2.3.5 Catalog Items

A **catalog item** is any metadata item (granule or collection) that is available for ordering from the ECHO system. To find the desired catalog items to order, queries are performed against the ECHO database. The results of a query may return several granules or collections. Catalog items are identified by a **catalog item GUID** (CatalogItemId, which is an assigned XML metadata tag).

To see the possible required/optional options for a catalog item, invoke the **GetCatalogItemOrderInformation** operation on the **OrderManagementService** passing the catalog item GUIDs of interest.

If a URL is provided, you (Client Partners) may retrieve the data from that URL as a direct link or obtain the data accessing instruction via the URL.

2.3.6 Orders

An **order** is a collection of **catalog** items that you, as a Client Partner, wish to have and would like to order from a Data Provider. Each item in the order is associated with a quantity and any options available for that item. Within ECHO, a user creates an order and then adds, deletes, and updates each item in the order before submitting the order to ECHO. Orders can also be created and submitted in a single web service API call (CreateAndSubmitOrder). Registered Client Partners can look at the status of their orders, as well as the history of all their submitted and shipped orders.

The **collection** of catalog items that comprises an order does not have to belong to one provider, but can span many providers. When organizing providers and catalog items within an order, another concept called a “provider order” is used. A provider order is a collection of all items in the original order that belong to a single provider. Since an order may contain orders from multiple providers, an order can consist of one or more provider orders. Each provider order can consist of one or more catalog items that belong to the same provider. To identify a specific provider order, you need the GUID of the order that includes that provider order and the GUID of the Data Partner associated with that provider order.

When a full order is submitted, ECHO splits the user’s order into separate provider orders and submits each provider order to the associated Data Provider.

The **OrderManagementService** allows users to create and change orders, provider orders, or individual catalog items. However, once the **SubmitOrder** operation is executed for a particular order within the **OrderManagementService**, the user can no longer execute any further changes on that order. A registered user may look at the current and historical status of any of their submitted orders.

Once a provider order is submitted to the appropriate provider, the status of that order can be changed in two ways:

- The Data Provider can send an immediate response, whether they will or will not accept the order, to an order submission.
- The Data Provider can wait and asynchronously use the **OrderProcessingService** to change the status of an order after they have had time to process the order.

2.3.7 Order Options (Used by Data Partners)

Data Partners use **order options** to describe the structure of the data to request of the client as well as how to display the order form to the client. They use ECHO Forms to perform both of these functions. For details about ECHO Forms, refer to the ECHO Forms schema and other information at http://www.echo.nasa.gov/data_partners/data_tools.shtml.

Option definitions contain a name, scope, deprecated flag, and an ECHO Form. Every option definition for a provider has a unique name. The **scope** indicates whether it is a system-level option definition or provider-level option definition. The **deprecated flag** indicates that you, as a Data Partner, have made that option definition obsolete. The deprecated flag indicates to clients that they should no longer use the option definition. The form part of the option definition contains an ECHO Form.

As of ECHO 10.1 data providers are able to supply two additional option definition fields: description and sort key. The new fields are available in a new extended option definition type, OptionDefinition2. The description field allows data providers to supply users with a longer description of the type or purpose of an option definition and it is intended for client display. The sort key allows data providers to indicate display order of their option definitions to users and is intended to be used by clients to sort option definitions before displaying to users.

The **OptionSelection** is the data from the client for a specific option definition. The selection should be put in the content part of the option selection. Options are also used in ECHO to describe authenticators and options for ordering data from a provider.

2.3.8 Groups

The term **groups** refers to an aggregating mechanism in ECHO that allows Client Partners to associate a Group name with a given set of users. When a group is created, the group’s owner specifies an ECHO user to be the group’s manager. However, group managers can be added and removed after creation by other group managers. After becoming a member of a group, a user can be granted access to restricted metadata via the Data Management Service.

2.3.9 Controlling Access to Metadata

ECHO provides a mechanism for controlling access to metadata. Data partners may restrict or permit users of the ECHO system to take action upon metadata. These actions currently include viewing, browsing, and ordering metadata. Data partners may create conditions which are used to specify characteristics of metadata. For example:

- 30 days old
- the month of September
- qaFlag2 value 3

When combined with a Comparator, Action, and Data Holding to create rules, conditions become powerful.

If a rule is a restriction, it applies to the entire ECHO populace. If a rule is a permission it applies only to members of the group specified.

In addition to the restrictions and permissions, a collection can be set to be restricted from viewing, browsing, and ordering by all users except the ones acting on behalf of the provider who owns the collection by simply setting its visibility flag to 'RESTRICT'. This restriction can be removed by simply change its visibility flag back to 'OPEN'. The restriction applied on the collection will also be applied on all its granules.

As a Client Partner, you may wish to remind your users of these data restrictions.

2.3.10 Extended Services

ECHO Extended Services allows partners to advertise and register web service interfaces, implementations, GUIs, and advertisements.

CHAPTER 3. LOGGING IN, SETTING UP, AND GETTING STARTED

This section contains information and examples that are common to most ECHO client applications, such as basic Login and Logout and creation and management of user accounts.

3.1 ECHO Tokens & User Contexts

Describe an ECHO token and what the different contexts are and what capabilties are in each.

Guest vs Registered users.

3.2 Creating and Managing ECHO Sessions

When using the Web Services API, you need to request an **ECHO token**. This token acts as your session key and must be passed to all other ECHO operations. All clients interfacing with the system are required to pass client identifier information to ECHO. The client identifier is a short description and/or name of the client. Client developers are encouraged to keep this information as concise as possible and to work with the ECHO Operations Group to create an appropriate identifier.

A token is obtained when logging in to ECHO (see 3.2.1, Logging In to ECHO). This is also done when setting user and provider context.

When done working in ECHO, be sure to logoff (see 3.2.2, Logging Out of ECHO.).

NOTE: If client identifier information is not provided, submitted orders will fail.

3.2.1 Logging In to ECHO

To obtain a token, call the Login operation of the Authentication Service. A new token is created and returned each time Login is invoked. Code Listing 1 is an example of logging in to ECHO and creating a session token for a guest user.

Parameters:

- username - Username of the user logging in
- password - Password of the user
- clientInfo - The string identifier of the ECHO client used to make this request
- actAsUserName - name of the user an Admin wants to act as, null for non ECHO administrator users
- behalfOfProvider - provider the user wants to act as , null for guests and registered users with no ProviderRoles

A Security Token is returned that is used for all subsequent calls to ECHO using the same Token profile.

Code Listing 1: Logging In as a Guest

```
// Client information is optional information provided by the
// client to ECHO when a user logs in
ClientInformation clientInfo = new ClientInformation();
clientInfo.setClientId("A Client");
clientInfo.setUserIpAddress("192.168.1.1");

// Call login with guest as username, email as password, and
// client information
String token =
      authenticationService.login("guest", "john@doe.com", clientInfo, null,
null);
```

Code Listing 2 is an example of logging in to ECHO and creating a session token for a guest user.

Code Listing 2: Logging In as a Registered User

```
// Client information is optional information provided by the
// client to ECHO when a user logs in
ClientInformation clientInfo = new ClientInformation();
clientInfo.setClientId("A Client");
clientInfo.setUserIpAddress("192.168.1.1");

// Call login with jdoe as username, mypass as password, and
// client information
String token =
      authenticationService.login("jdoe", "mypass", clientInfo, null, null);
```

3.2.2 Logging Out of ECHO

When you are finished with a token, for example, you have finished a session with ECHO; destroy the token using the Logout operation.

Parameter(s):

- token - security token

Code Listing 3: Logging out of ECHO

```
// Logout and set token to null because it is not useful anymore
authenticationService.logout(token);
token = null;
```

You do not need to destroy a token after each call; you may reuse a token until it is destroyed with the Logout operation or the token expires.

Because the token is used to track your session, it must be protected by client applications with the same level of security that you use for your login name and password.

3.3 Interacting with ECHO

Interacting with the rest of the ECHO API follows the same pattern as logging in and logging out except that it requires that you pass a valid ECHO token to each operation. The following example shows logging in, retrieving the version number of the ECHO system and logging back out.

Code Listing 4: Getting the ECHO Version Number

```
// Login
String token =
    authenticationService.login("jdoe", "mypass",
    new ClientInformation("A Client", "192.168.1.1"), null, null);

// Print out echo version number.
```

```
System.out.println("ECHO's version number: "
              + authenticationService.getECHOVersion(token));

// Logout using token from previous login
authenticationService.logout(token);
token = null;
```

3.4 User Accounts

Personally Identifiable Information (PII) *- information that can be used to uniquely identify, contact, or locate a single person or can be used with other sources to uniquely identify a single individual*

ECHO regularly identifies and removes any PII found in ECHO user accounts. As an ECHO client, if you support user account creation, please help us avoid recording PII. Users should be encouraged not to enter custom Address and Phone labels that appear to be associated with their home (e.g. 'home office').

Use the UserService to update information such as addresses, e-mail addresses, and phone numbers associated with a particular user. A feature of the ECHO system allows you the option to store multiple addresses and phone numbers distinguished by unique names, so you can later choose from among them. For example, you may set up an address in your profile where the AddressName value is "Work" and set up another address where the AddressName value is "Home." The API does not explicitly connect these, but a client interface can query for a list of addresses and fill in the blanks in the other API operations appropriately.

A user account has two basic sets of information associated with it:

a. **User Profile:** Contains the personal information specific to the user who owns the currently logged in userid. This information includes the user's Profile, Phone Numbers, and Addresses.

   1) User Name/User ID
   2) Full Name: Title, First Name, Middle Initial, Last Name
   3) Organization Name
   4) User Domain
   5) User Region
   6) Primary Study Area
   7) User Type
   8) Email
   9) Opt-In (for email notifications concerning changes within ECHO; defaults to FALSE or No)
   10) When creating the user account: Password
   11) Roles
   12) Phone Number(s)

       For each Phone Number:

       a) Phone Type*
       b) Phone Number*

13) Address(s)

    For each address:

    a) US Format Flag
    b) Address Name
    c) Up to 5 street address lines
    d) City
    e) State
    f) Zip/Postal Code
    g) Country
    h) Special Instructions

b. **User Preferences:** Contains information for ECHO to use when processing your queries, subscriptions, orders, etc.

   1) Order Notification Level—the level of details to receive for status updates on submitted orders
   2) Custom Properties XML—includes XML properties required by an ECHO client application
   3) Contacts—general, shipping, and billing contacts for you as a user, in the event you wish to order data
      a) General Contact—who to contact with questions about an order
      b) Shipping Contact—who to ship the order to
      c) Billing Contact—who to bill the order
      d) Each contact contains:
         (1) Full Name: Title, First Name, Middle Initial, Last Name
         (2) Organization Name
         (3) Role
         (4) Email
         (5) Mailing Address
             (a) US Format Flag
             (b) Address Name
             (c) Up to 5 street address lines
             (d) City
             (e) State
             (f) Zip/Postal Code
             (g) Country
             (h) Special Instructions
         (6) Phone Number(s)

             For each Phone Number:

             (a) Phone Type*
             (b) Phone Number*

3.4.1 Addresses

You are only required to submit address information to the ECHO system if you plan to order data, and then you are required to submit a shipping address, a billing address, or a contact address.

An ECHO Address entity consists of an address name, a U.S. format flag, five street address lines, and city, state, zip code, and country fields. The address name, first address line, city, and country are required fields.

The address name represents a unique name for the address entity like "Field Office" or "Work".

The country field is a 30-character free-form text field that is not validated.

The U.S. format flag defaults to "TRUE" which is taken to mean the address is in the U.S. standard address format. With U.S. addresses, the state and zip code fields are also required. If this flag is set to "FALSE", then only the basic fields are required (address name, first address line, city, country).

3.4.2 E-mail

Only one e-mail address can be associated with a user account. The rules for an e-mail address in the ECHO system are consistent with global standards for e-mail addresses: username@domain.

3.4.3 Phone Numbers

As with the Address entity, you may store multiple phone numbers in the Phone Number entity. Each phone number is assigned with a **PhoneNumberType** from a list of common phone number types (BUSINESS, BUSINESS_2, BUSINESS_FAX, MOBILE, PAGER) and a custom type. **Custom** can be used if one of the phone number types available does not meet your needs. The actual phone number is stored as a string in **Number**.

3.4.4 User Domain and User Region

User Domain indicates the domain you are in such as government, commercial, or education (GOVERNMENT, K12, UNIVERSITY, COMMERCIAL).

User Region specifies whether you are located in the U.S. (USA or INTERNATIONAL)

3.4.5 Password

ECHO requires your password to have at least 10 characters and at least three of the following types of characters:

- Upper case letters
- Lower case letters
- Digits
- Any other special characters such as “$”, “&”, “>”, “<”, ...

3.4.6 Creating a User Account

To create a new user account with ECHO, fill in the User object including the phone numbers and other user attributes described above, and pass the object to the **CreateUser** operation on the **UserService**.

All Globally Unique Identifiers (GUIDs) should be set to null when creating a new user. The system will create and assign GUIDs when it creates the account and return the user GUID from the operation.

You may be logged in as a guest or authenticated user when creating a new user account.

Code Listing 5: Creating an ECHO Account

```
// Create work address for user
```

```
Address address = new Address();
address.setAddressName("Work");
address.setStreet1("123 Main Street");
address.setCity("Baltimore");
address.setCountry("USA");
address.setState("MD");
address.setUsFormat(true);
address.setZip("12345");

// Create business phone
Phone phone = new Phone();
phone.setNumber("443-555-5555");
phone.setPhoneNumberType(PhoneType.BUSINESS);

// Create user object
User user = new User();
user.setDomain(UserDomain.K12);
user.setRegion(UserRegion.USA);
user.setFirstName("John");
user.setLastName("Doe");
user.setOrganizationName("EarthSpace Inc.");
user.setEmail("jdoe@earthspace.com");
user.setPhones(new Phone[] { phone });
user.setAddresses(new Address[] { address });

// Use a strong password for user
String password = "K93FeS3e";

// Create user in ECHO
String userGuid = userService.createUser(guestToken, password, user);
```

Once you have a valid user name and password, you may login to ECHO.

CHAPTER 4. QUERYING FOR EARTH SCIENCE METADATA

ECHO uses the **ECHO Alternative Query Language (AQL)** for its querying capabilities**.** (See Chapter 6 for a detailed explanation of the language syntax.) To support potentially large queries, ECHO handles a query expression without regard to the details of whether and how it will return query results to the user.

An ECHO query consists of a query expression specified in XML, starting with <query>. All AQL queries must conform to the AQLQueryLanguage.dtd available on the ECHO website. Also, refer to Chapter 6, The ECHO Alternative Query Language for additional information about AQL.

You should validate your query against the DTD ***before*** *passing it to ECHO. Since a query is passed to ECHO as a string, the query will not be validated against the DTD by the Web Service processing layer but rather at execution time, which, in the case of an asynchronous query or a subscription, could be after the Web Service call has completed.*

You may use the optional argument **MaxResults** to limit the numbers of results returned from a query, which is useful when a query produces more data than can be processed. This also saves processing time for the query and presentation of results.

You may retrieve the results of a query in several different ways. The **ExecuteQuery** operation on the Catalog Service allows you to indicate whether you would like the data itself returned or simply the number of hits. When doing so, ensure that the **CatalogItemID** tag is returned. The string value under this tag is the actual catalog item GUID that you can use to order items from ECHO. You can specify this function in the **ResultType** argument with one of the following values:

Table 2: Query Return Result Types

Value	Description
RESULTS	Returns the detailed metadata for items that match the query directly in the response. When using this option, you may choose to limit the actual metadata values returned. In addition, ECHO will return a result set identifier (ResultSetGUID) for subsequent retrievals of the results or for paging through the result list. *Note that ECHO Operations limits the maximum number of items returned to 2,000 at a time.* The complete results are stored in your result set which you can retrieve by using the GetQueryResults operation.
RESULT_SET_GUID	Returns the result set guid of the results that are stored on the server. ECHO will generate a result set but will not return any results. You must subsequently retrieve the results using the GetQueryResults operation.
HITS	Returns the number of hits (matches) to the query and a ResultSetGUID for the results stored on the server. ECHO will generate a result set but will not return any results. The number of records may be a statistically determined for large result sets. You must subsequently retrieve the results using the GetQueryResults operation. Hits is a relatively expensive operation therefore if the client only needs to know if some data exists, it is faster to simply query for ITEM_GUIDS with a small iterator size.
ITEM_GUIDS	Returns the Catalog Item GUIDs that match the specified query. *Note: No ResultSetGUID is returned since results do not persist in the system.* All the GUIDs of the granules/collections that satisfy the query are returned to the client. It is the client's responsibility to request the metadata for each individual granule/collection using the GetCatalogItemMetadata operation discussed later.

4.1 Formatting Your Query Results

Not a good title for this section.

You can specify a subset of the information in the result set by using different parameters for the operations **ExecuteQuery** and **GetQueryResults**.

The following elements are used to specify the format and content of a result set:

Table 3: Result Set Content Elements

Argument	Description
IteratorSize	Specifies the number of results to be returned from a single operation. This does not limit the number of items a query may match (see MaxResults) but limits to 2,000 the number of matching items returned in the result set, starting from the Cursor position. This field is only used if the result type is set to RESULTS.
Cursor	Specifies the index of the first record to be returned in the result set. For example, a value of 5 will return results starting from the fifth record. If none is specified, it defaults to 1. If you repeat the same query later, use the same Cursor value. This field is only used if the result type is set to RESULTS.
MetadataAttributes	Specifies which fields of the ECHO Metadata you actually want to return. By only requesting the parts of the metadata you are interested in, you can increase query performance substantially. By default, ECHO returns all of the metadata for each item. This field is only used if the result type is set to RESULTS.

Metadata results are returned as XML that conforms to one of the following DTDs:

- Granule metadata conforms to the Granule Results DTD—refer to Appendix F, Results DTDs (also located at: http://www.echo.nasa.gov/reference/reference.shtml).
- Collection metadata conforms to the Collection Results DTD Appendix F, Results DTDs (also located at: http://www.echo.nasa.gov/reference/reference.shtml).

Metadata attributes are made up of two values: the XML metadata attribute name and a primitive type name. ***ECHO currently ignores the type name***. The allowable metadata attribute names are specified in the appropriate DTD (ECHOGranuleResults.dtd for granules and ECHOCollectionResults.dtd for collections). If you specify a metadata attribute name that has sub-attributes, all of the sub-attributes will be included as well. For example, if you specify **Platform**, the following elements will be included in the metadata:

- Platform
- PlatformShortName
- Instrument
- InstrumentShortName
- Sensor
- SensorShortName
- SensorCharacteristics
- SensorCharacteristicName
- SensorCharacteristicValue
- OperationMode

When you specify a sub-attribute, ECHO will return the “parent” attribute in the hierarchy as well as the sub-attribute. This allows you to ensure that data are correctly scoped. For example, if you specify **Sensor**, the following elements will be included in the metadata:

- Platform
- PlatformShortName
- Instrument

- InstrumentShortName
- GranuleUR
- GranuleURMetaData

Detailed spatial attributes cannot be used as MetadataAttributes; only their containing element may be specified. For example, you cannot use **BoundingBox** as a MetadataAttribute, but you can use **HorizontalSpatialDomainContainer**. The following spatial elements cannot be specified as MetadataAttributes:

- Point
- Circle
- BoundingRectangle
- GPolygon
- Polygon
- PointLongitude
- PointLatitude
- CenterLongitude
- CenterLatitude
- Radius
- WestBoundingCoordinate
- NorthBoundingCoordinate
- EastBoundingCoordinate
- SouthBoundingCoordinate
- Boundary
- ExclusiveZone
- SinglePolygon
- MultiPolygon
- OutRing
- InnerRing

Specifying GranuleURMetaData as a MetadataAttribute is equivalent to not specifying any MetadataAttributes; the result set includes all the elements in the result DTD.

The following code snippet shows how to execute a query for all of the metadata for matching items.

Code Listing 6: Executing a Simple Query

```
// Execute a query to get results
QueryResponse response =
            catalogService.executeQuery(userToken, queryString,
            ResultType.RESULTS,
            10, // Iterator
            0, // Cursor
            3000, // max results
            null); // no metadata attributes specified
```

The following code snippet shows the same query but restricts the returned information to just the spatial container information.

Code Listing 7: Executing a Query for Specific Metadata

```
MetadataAttribute[] attributes =
    new MetadataAttribute[] { new MetadataAttribute(
    "HorizontalSpatialDomainContainer", null) };

QueryResponse response =
    catalogService.executeQuery(userToken, queryString,
                ResultType.RESULTS,
                10, // Iterator
                0, // Cursor
                3000, // max results
                attributes);
```

4.2 Handling Large Result Sets

Given ECHO's large store of Earth Science data, it is possible for queries to return very large result sets. ECHO supports retrieving the results from a query in a number of ways. The simplest is to ask ECHO to return the results directly from the **ExecuteQuery** request by passing **RESULTS** as the **ResultType**. However, to prevent a single query from monopolizing ECHO resources, ECHO limits the number of results available in response to a query. By default, this limit is 2,000 items. ECHO Operations may change this limit depending on ECHO usage patterns.

For larger results, ECHO supports a paging mechanism. This allows you to page through the available data in page sizes that you select (up to the ECHO Operations configurable limit). For all **ResultTypes** ECHO will create and store a result set and return the corresponding GUID. You can page through the result set using the **GetQueryResults** operation. The arguments to **GetQueryResults** are similar to **ExecuteQuery** with the exception that you specify the result set GUID rather than a new query.

Result sets may change after they are created. Providers are continually changing the data they have registered in ECHO. New records may appear or may be removed from a result set. Because of this, you should watch the fields **Cursor** and **CursorAtEnd** when paging through a large result set:

Cursor specifies the index of the first record to be returned in the result set. For example, a value of 5 will return results starting from the fifth record. If none is specified, it defaults to 1. If you repeat the same query later, use the same Cursor value.

Use **CursorAtEnd** to determine when you have reached the end of the result set. This Boolean field is TRUE if the returned results were the last available results in the result set.

The following code illustrates paging through a result set and displaying it to the user.

Code Listing 8: Paging Through Query Results

```
    final int ITERATOR_SIZE = 10;
    try
    {
      CatalogServiceLocator catalogServiceLocator =
          new CatalogServiceLocator();
      CatalogServicePort catalogService =
          catalogServiceLocator.getCatalogServicePort();
      QueryResponse response =
          catalogService.executeQuery(userToken, userQuery,
              ResultType.RESULT_SET_GUID, 0, 0, 1000, null);
      String resultSetGuid =
          response.getResults().getResultSetGuid();

      // begin paging through results
      int cursor = 1;
      boolean atEnd = false;

      while (!atEnd)
      {
        //Get next ITERATOR_SIZE results
        QueryResults results =
            catalogService.getQueryResults(userToken,
                resultSetGuid, null, ITERATOR_SIZE, cursor);

        //Print out results
        System.out.println(results.getReturnData());

        //Set cursor to next index
        cursor = results.getCursor();

        //Check if at end of result set
        atEnd = results.isCursorAtEnd();
      }
      System.out.println("All results retrieved");
    }
    catch (EchoFault e)
    {
      e.printStackTrace();
    }
    catch (ServiceException e)
    {
      e.printStackTrace();
    }
    catch (RemoteException e)
    {
      e.printStackTrace();
    }
```

*Like **ExecuteQuery**, **GetQueryResults** takes an array of **MetadataAttributes**. Internally ECHO only stores in a result set the item IDs that match a given query. This means that you may pull different metadata from a single result set with each call by varying what you pass to the **MetadataAttribute** array without needing to re-query ECHO. It is highly recommended you use the **MetadataAttribute** array to restrict the information ECHO returns and thus improve performance.*

4.3 Visibility of Results

Pull this out to an earlier section where an overview of data access control can be discussed.

When you execute a query, the query is applied to all the data in ECHO. However, when the results are retrieved, you may not see all of the items. What you can see depends on the rules defined by the Data Partners and the privileges granted to you.

4.3.1 Restricted Items

If a particular item in your result set is restricted for you (i.e., you are not allowed to see it), based on your privileges, it will not be returned.

4.3.2 Deleted Items

It is possible that between the time you execute a query and the time you view the results some of the matched items may have been deleted from ECHO or restricted due to a request from the Data Partner who owns the metadata. In that case, the item will not be returned in your result set. For more information about notification of deleted or restricted order items, refer to section 7.8.1, Restricted or Deleted Order Items.

4.3.3 Querying for Orderable Data

Since ECHO 9.0, you have been able to exclude from your query data that cannot be ordered. Refer to section 1.1.1, .

4.4 Searching for Orbit Data

Probably want to pull this out and have a whole section regarding spatial searching information.

4.4.1 Backtrack Orbit Search Algorithm

Orbit searching is by far the most accurate way to search for level 0-2 orbital swath data. Unfortunately orbital mechanics is a quite difficult field, and the most well known orbit model, the NORAD Propagator, is quite complex. The NORAD Propagator is designed to work with a wide range of possible orbits, from circular to extremely elliptical, and consequently requires quite a bit of information about the orbit to model it well.

To facilitate earth science, the orbits of satellites gathering earth science data are quite restricted compared to the variety of orbits the NORAD Propagator is designed to work with. Generally, the earth science community would like global coverage, with a constant field of view, at the same time every day. For this reason, most earth science satellites are in a sun-synchronous, near-polar orbit. Even missions that are not interested in global coverage, e.g., the Tropical Rainfall Measuring Mission (TRMM), are still interested in having a constant field of view so the coverage of the sensor is at a constant resolution. For this reason, ALL earth science satellites are in circular orbits.

The Backtrack Orbit Search Algorithm, designed and developed by Ross Swick, exploits this fact to simplify the orbit model by modeling an orbit as a great circle under which the Earth rotates. This reduces the number of orbital elements required for the model from 22 to three. Moreover, the NORAD Propagator is designed to predict future orbits based on current status, and consequently must be reinitialized periodically to correct for cumulative error as the model spins forward. As the name implies Backtrack spins the orbit backwards, and in practice spins backwards at most one orbit, so there is no cumulative error.

For more information on Backtrack, please see http://geospatialmethods.org/bosa/.

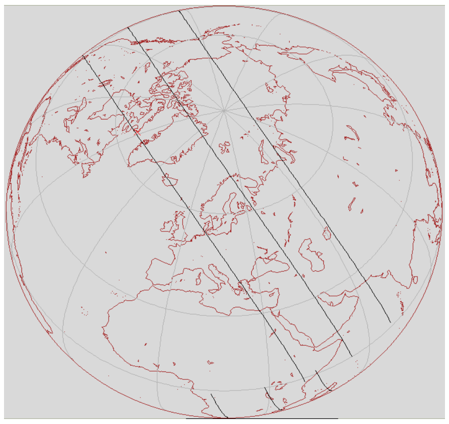
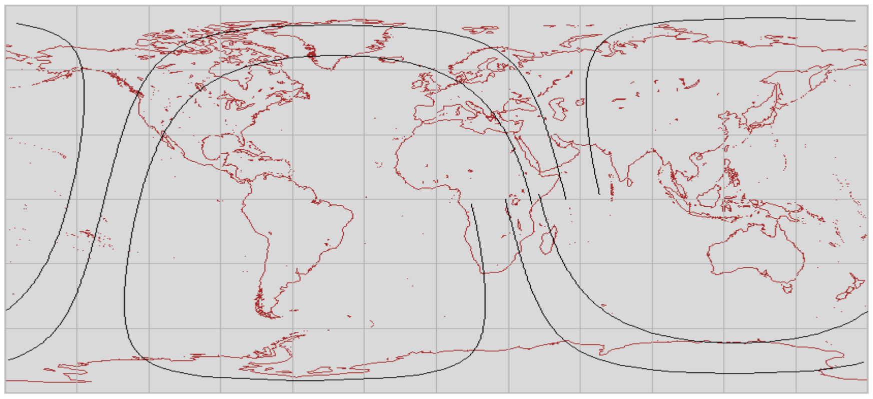



Figure 2. Typical Orbit Path Represented on a Globe and the same Path on a Map

4.4.1.1 Backtrack orbit model

Three parameters to define an orbit:

a. Instrument swath width (in kilometers)
b. Satellite declination or inclination (in degrees)
c. Satellite period (in minutes)

4.4.1.2 Orbit data representation

Three parameters to represent orbit data:

a. Equatorial crossing longitude
b. Start circular latitude (or start latitude and start direction)
c. End circular latitude (or end latitude and end direction)

4.4.1.3 How ECHO Searches for Orbit Data

a. The user specifies a regular spatial window

```
<granuleCondition>
   <spatial>
      <IIMSPolygon>
         <IIMSLRing>
            <IIMSPoint lon="-90" lat="49" />
            <IIMSPoint lon="-90" lat="39" />
            <IIMSPoint lon="-70" lat="39" />
            <IIMSPoint lon="-70" lat="49" />
            <IIMSPoint lon="-90" lat="49" />
         </IIMSLRing>
      </IIMSPolygon>
      <SpatialType>
         <list> <value>ORBIT</value> </list>
      </SpatialType>
   </spatial>
</granuleCondition>
```

Figure 3. Spatial Window

b. Backtrack then calculates from both ascending and descending a path for equatorial longitude crossings and start/end circular latitudes according to user's query window

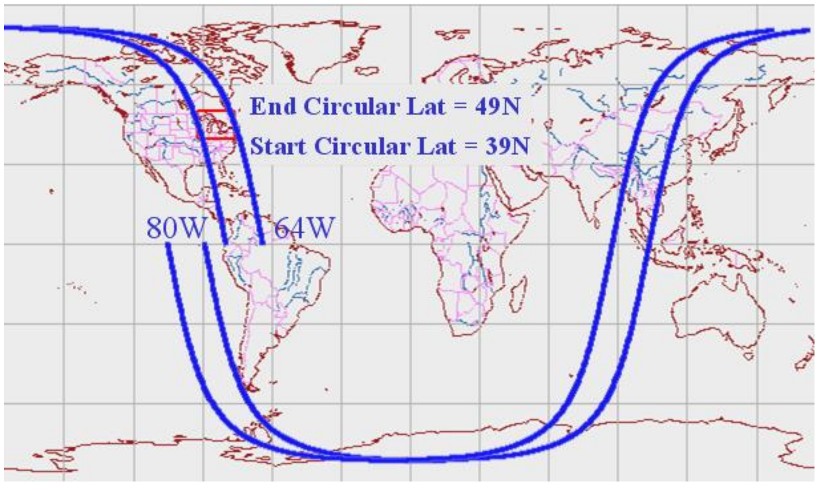


Figure 4. Search Ascending Path

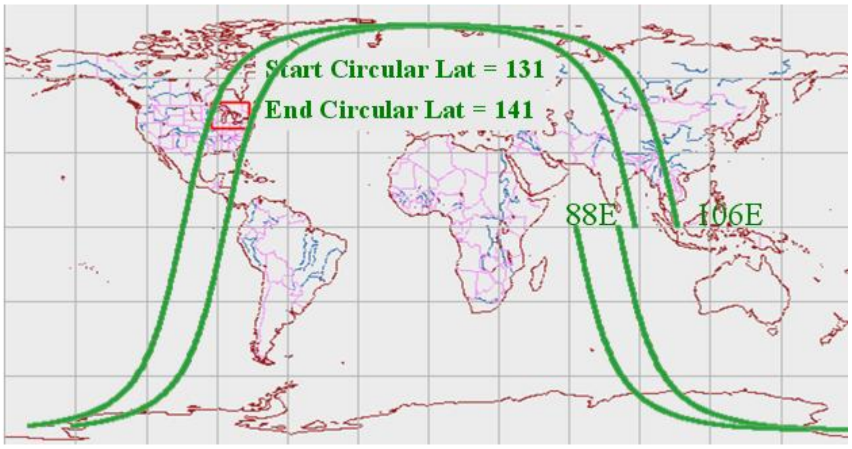


Figure 5. Search Descending Path

4.5 Sample Queries

The following are sample queries that you can execute against ECHO. Note that the provider and the datasets used in these samples are representative only; you should modify the query to suit your needs.

Code Listing 9: Sample Collection Query (Discovery Search)

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE query PUBLIC "-//ECHO CatalogService (v10)//EN"
"http://api.echo.nasa.gov/echo/dtd/IIMSAQLQueryLanguage.dtd">
<!--
  Search for collections from ORNL_DAAC that have
  parameter value that contains 'IMAGERY'
-->
<query>
  <for value="collections"/>
  <dataCenterId>
    <list><value>ORNL_DAAC</value></list>
  </dataCenterId>
  <where>
    <collectionCondition>
      <parameter>
```

```
        <textPattern>'%Imagery%'</textPattern>
      </parameter>
    </collectionCondition>
  </where>
</query>
```

Code Listing 10: Sample Collection Query from Two Providers (Discovery Search)

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE query PUBLIC "-//ECHO CatalogService (v10)//EN"
"http://api.echo.nasa.gov/echo/dtd/IIMSAQLQueryLanguage.dtd">
<!--
  Search for collections from GSFCECS and ORNL_DAAC that have
  processing level 1A or 2
-->
<query>
  <for value="collections"/>
  <dataCenterId>
    <list>
      <value>GSFCECS</value>
      <value>ORNL_DAAC</value>
    </list>
  </dataCenterId>
  <where>
    <collectionCondition negated="y">
      <processingLevel>
        <list>
         <value>'1A'</value>
         <value>'2'</value>
        </list>
      </processingLevel>
    </collectionCondition>
  </where>
</query>
```

Code Listing 11: Sample Collection Query with Temporal and Spatial Constraints (Discovery)

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE query PUBLIC "-//ECHO CatalogService (v10)//EN"
"http://api.echo.nasa.gov/echo/dtd/IIMSAQLQueryLanguage.dtd">
<!--
Search for collections from ORNL_DAAC with:
temporal range: periodic range between Jan 1, 1990 and Dec. 31 1998from the
1st to the 300th day of each year, AND
spatial extent: bounding box 60S, 70W to 60N, 70E.
-->
<query>
  <for value="collections"/>
  <dataCenterId>
    <value>ORNL_DAAC</value>
  </dataCenterId>
  <where>
    <collectionCondition>
      <temporal>
```

```
        <startDate>
          <Date YYYY="1990" MM="01" DD="01"/>
        </startDate>
        <stopDate>
          <Date YYYY="1998" MM="12" DD="31"/>
        </stopDate>
        <startDay value="1"/>
        <endDay value="300"/>
      </temporal>
    </collectionCondition>
    <collectionCondition negated="n">
      <spatial operator="RELATE">
        <IIMSPolygon>
          <IIMSLRing>
            <IIMSPoint long='-10' lat='85'/>
            <IIMSPoint long='10' lat='85'/>
            <IIMSPoint long='10' lat='89'/>
            <IIMSPoint long='-10' lat='89'/>
            <IIMSPoint long='-10' lat='85'/>
           </IIMSLRing>
         </IIMSPolygon>
       </spatial>
     </collectionCondition>
  </where>
</query>
```

Code Listing 12: Sample Collection Query with Complex Temporal and Spatial Conditions (Discovery)

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE query PUBLIC "-//ECHO CatalogService (v10)//EN"
"http://api.echo.nasa.gov/echo/dtd/IIMSAQLQueryLanguage.dtd">
<!--
  Search for collections from ORNL_DAAC with
  temporal range: periodic range between Jan 1, 1990 and Dec. 31 1998
  from the 1st to the 300th day of each year, AND
  some days of January.
  source name: L7 or AM-1 AND
  spatially covering any 'temperate' region or USA
-->
<query>
  <for value="collections"/>
  <dataCenterId>
    <list><value>ORNL/value></list>
  </dataCenterId>
  <where>
    <collectionCondition>
      <temporal>
        <startDate>
          <Date YYYY="1990" MM="01" DD="01"/>
        </startDate>
        <stopDate>
          <Date YYYY="1998" MM="12" DD="31"/>
        </stopDate>
        <startDay value="1"/>
        <endDay value="300"/>
      </temporal>
    </collectionCondition>
    <collectionCondition negated='n'>
      <sourceName>
        <list>
          <value>'L7'</value>
          <value>'AM-1'</value>
        </list>
      </sourceName>
    </collectionCondition>
    <collectionCondition>
      <spatialKeywords>
        <list>
          <value>'temperate'</value>
          <value>'USA'</value>
        </list>
      </spatialKeywords>
    </collectionCondition>
    <collectionCondition>
      <temporalKeywords>
      <textPattern>'%january%'</textPattern>
     </temporalKeywords>
   </collectionCondition>
  </where>
</query>
```

Code Listing 13: Sample Collection Query Using Provider Specific Attributes (Discovery)

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE query PUBLIC "-//ECHO CatalogService (v10)//EN"
"http://api.echo.nasa.gov/echo/dtd/IIMSAQLQueryLanguage.dtd">
<query>
<for value="collections"/>
<dataCenterId>
  <value>ORNL_DAAC</value>
</dataCenterId>
<where>
  <collectionCondition>
    <additionalAttributeNames>
      <list>
        <value>'Provider_Specific_Attribute_1'</value>
        <value>'Provider_Specific_Attribute_3'</value>
      </list>
    </ additionalAttributeNames >
  </collectionCondition>
</where>
</query>
```

CHAPTER 5.

THE ECHO ALTERNATIVE QUERY LANGUAGE LANGUAGE

ECHO Alternative Query Language (AQL) is a query language that defines the format for searches on collections and granules in the ECHO system. AQL is an XML-based language. You can find the DTD for AQL at http://api.echo.nasa.gov/echo/dtd/IIMSAQLQueryLanguage.dtd

Code Listing 14: General AQL Structure

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE query PUBLIC "-//ECHO CatalogService (v10)//EN"
"http://api.echo.nasa.gov/echo/dtd/IIMSAQLQueryLanguage.dtd">
<query>
  <for value= "collections"/>
  //"granules" can be substituted for "collections"
  <dataCenterId>
    <all/>
  </dataCenterId>
  <where>
    <list of conditions ... >
  </where>
</query>
```

Note: The <for/> tag shown in this example does not require that you set a value attribute; if you do not explicitly set this attribute, it will default to "collections." Your query will validate correctly, but you may still experience an error if you use granule settings for other attributes within the same query.

There is no discussion regarding the strong suggestion that clients include dataset IDs. Might want to have more high level information regarding the structure of an AQL query and general contructs (list, all, value, etc).

You can specify the data centers that you wish to search by explicitly listing them or by using the empty element **<all/>** to indicate that you want all the data centers searched. This is the default condition, that is, if you do not specify a condition for the **dataCenterId** element, ECHO will search all data centers. *Do not enclose **dataCenterId** values in single-quotes. Is this still needed?*

To search all data providers:

```
<dataCenterId><all/></dataCenterId>
```

To search for collections/granules in the ORNL data provider's metadata only:

```
<dataCenterId>
  <value>ORNL_DAAC</value>
</dataCenterId>
```

To search for collections/granules in the LPDAAC_ECS data providers' metadata only:

```
<dataCenterId>
  <list>
    <value>ORNL_DAAC</value>
    <value>LPDAAC_ECS</value>
  </list>
</dataCenterId>
```

The list of conditions consists of **collectionCondition** elements for Discovery or **granuleCondition** elements for Inventory Search. The fields you can search on within collections occur as children of the **collectionCondition** element. The fields you can search on within granules occur as children of the **granuleCondition** element. ECHO will return only those granules or collections that satisfy all the conditions of the query, that is, ECHO applies the Boolean AND between all conditions of the query.

The **where** tag can have any number of **collectionCondition** or **granuleCondition** elements. Each of these tags can contain any one of the search elements listed in the Inventory Search and Discovery Search tables below. For the query to be valid, each of the search elements may appear only once.

Code Listing 15 shows the general structure of a Discovery query with multiple constraints.

Code Listing 15: Structure of a Discovery Query with Multiple Collection Conditions

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE query PUBLIC "-//ECHO CatalogService (v10)//EN"
"http://api.echo.nasa.gov/echo/dtd/IIMSAQLQueryLanguage.dtd">
<query>
  <for value="collections"/>
  <dataCenterId>
    <value>ORNL_DAAC</value>
  </dataCenterId>
  <where>
    <collectionCondition>… </collectionCondition>
    <collectionCondition>… </collectionCondition>
    …
  </where>
</query>
```

Code Listing 16 shows the general structure of an Inventory query with multiple constraints.

Code Listing 16: Structure of an Inventory Query with Multiple Granule Conditions

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE query PUBLIC "-//ECHO CatalogService (v10)//EN"
"http://api.echo.nasa.gov/echo/dtd/IIMSAQLQueryLanguage.dtd">
<query>
  <for value="granules"/>
  <dataCenterId>
    <value>ORNL_DAAC</value>
  </dataCenterId>
  <where>
    <granuleCondition>… </granuleCondition>
    <granuleCondition>… </granuleCondition>
    …
  </where>
</query>
```

If you specify a list or a single value, then the search looks for an exact match between the string specified and the data stored. For example, if the search value is 'Imagery' and the data stored has the value 'Satellite Imagery', the data will not be returned since there was no exact match. In this instance, it is more useful to use the **textPattern** element for the search.

6.1 Collection/Discovery Search

Searches for collections must enclose the search criteria in a **collectionCondition** element. If you want to search the negated criteria, you should set the **negated** attribute in the **collectionCondition** element to **'Y'**. Code Listing 17 shows how to create a search for all collections except the ones with processing level 1, 1A, 1B, or 2.

Code Listing 17: Using the Negated Attribute on Collection Conditions

```
<collectionCondition negated='Y'>
  <processingLevel>
    <list>
      <value>'1'</value>
      <value caseInsensitive=”Y”>'1A'</value>
      <value>'1B'</value>
      <value>'2'</value>
    </list>
  </processingLevel>
</collectionCondition>
```

You can set the negated attribute to **'Y'** for a criterion.

The following table lists the criteria you can use to search for collections. For details about each of these criteria, refer to section 6.3, Common Search Elements

Table 4: Collection Search Criteria (Discovery)

Search Criteria	XML Element
Campaign Short Name	<CampaignShortName>...</CampaignShortName>
Dataset ID	<dataSetId>...</dataSetId>
ECHO Insert Date	<ECHOInsertDate>...</ECHOInsertDate>
ECHO Last Update	<ECHOLastUpdate>...</ECHOLastUpdate>
Online Collections Only	<onlineOnly/>
Parameter	<parameter>...</parameter>
Processing Level	<processingLevel>...</processingLevel>
Sensor Name	<sensorName>...</sensorName>
Short Name	<shortName>...</shortName>
Source Name	<sourceName>...</sourceName>
Spatial	<spatial>...</spatial>
Spatial Keywords	<spatialKeywords>...</spatialKeywords>
Temporal	<temporal>...</temporal>
Temporal Keywords	<temporalKeywords>...</temporalKeywords>
Additional Attribute Names	<additionalAttributeNames>...</additionalAttributeNames>
Orderable Items	<orderable/>

Search Criteria	XML Element
Version ID	<versionId>...</versionId>
Archive Center	<archiveCenter>...</archiveCenter>
Additional Attributes	<additionalAttributes>… </additionalAttributes>
Instrument Short Name	<instrumentShortName>…</instrumentShortName>

6.2 Granule/Inventory Search

Searches for granules must enclose the search criteria in the **granuleCondition** element. As in the case of **collectionCondition**, if you want to search the negated criteria, set the **negated** attribute in the **granuleCondition** element to **'Y'**. You can set the negated attribute to **'Y'** for any criterion.

The following table lists the criteria you can use to search for granules.

Table 5: Granule Search Criteria (Inventory)

Search Criteria	XML Element
Only Granules with Browse Data	<browseOnly/>
Campaign Short Name	<CampaignShortName>...</CampaignShortName>
Percentage of cloud Cover	<cloudCover>...</cloudCover>
Dataset ID	<dataSetId>...</dataSetId>
ECHO Insert Date	<ECHOInsertDate>...</ECHOInsertDate>
ECHO Last Update	<ECHOLastUpdate>...</ECHOLastUpdate>
Either Day or Night Granules Only	<dayNightFlag/>
Search on ECHO granule IDs (formerly granuleId)	<ECHOGranuleID>...</ECHOGranuleID>
Search on Granule UR (provider specific)	<GranuleUR>...</GranuleUR>
Online Granules Only	<onlineOnly/>
Two-D Coordinate System	<TwoDCoordinateSystem>...</TwoDCoordinateSystem>
Producer Granule ID	<ProducerGranuleID>...</ ProducerGranuleID>
Additional Attributes	<additionalAttributes>...</additionalAttributes>
Sensor Name	<sensorName>...<sensorName>
Source Name	<sourceName>...</sourceName>
Spatial	<spatial>...</spatial>
Temporal	<temporal>...</temporal>
Orderable Items	<orderable/>
Version ID	<versionId>...</versionId>
PGE Name	<PGEName>...</PGEName>
PGE Version	<PGEVersion>...</PGEVersion>
Measured Parameters	<measuredParameters>...</measuredParameters>
Provider Production Date	<providerProductionDate>…</providerProductionDate>
Provider Insert Date	<providerInsertDate>…</providerInsertDate>

Search Criteria	XML Element
Instrument Short Name	<instrumentShortName>…</instrumentShortName>

Effective with ECHO Release 7.0, the ***LocalGranuleID*** *search criterion was renamed* ***ProducerGranuleID****.*

Refer to Appendix F, Results DTDs for the complete DTD.

6.3 Common Search Elements

You may use the following search criteria for both collection and granule searches.

6.3.1 Case Insensitive Searching

Any **value** or **textPattern** tag has an attribute **caseInsensitive** that you can set to **Y** or **N** to indicate whether the search **value** or **textPattern** is case insensitive. The default is **N**, that is, the default is case sensitive searching. Refer to the dataSet ID example on the next page for an example.

6.3.2 CampaignShortName

CampaignShortName is the name(s) of the campaign or project that gathered data associated with the collection or granule. In **CampaignShortName**, you can use a *single-quoted string* in a **value**, a list of *single-quoted strings* in a **list**, or a **textPattern** element as defined in the section 6.8, Miscellaneous Elements.

This example shows a search for collections/granules where **CampaignShortName** = 'River'.

```
<CampaignShortName>
  <value>'River'</value>
</CampaignShortName>
```

This example shows a search for collections/granules where **CampaignShortName** = 'River' or **CampaignShortName** = 'Lake'.

```
<CampaignShortName>
  <list>
    <value>'River'</value>
    <value>'Lake'</value>
  </list>
</CampaignShortName>
```

This example shows a search for collections/granules where **CampaignShortName** contains the string 'AS_A%D', where the % represents zero or more numbers or letters between the *A* and the *D* in the text string 'AS_A%D'

```
<CampaignShortName>
  <textPattern operator="LIKE">'AS_A%D'</textPattern>
</CampaignShortName>
```

6.3.3 DataSetID

dataSetID specifies the universal name of a collection. You can use this element to restrict the search to a few collections, using the **value** element to specify a single collection, a **list** for a list of collections, or a **textPattern**. For the **value** and **list** elements, you must know the exact name of the collection. For example, you may have performed a Discovery search to locate the collection of interest and now want to perform an Inventory search for granules.

This example shows a search for all collections whose **dataSetId** ends with '1A'.

```
    <dataSetId>
      <textPattern caseInsensitive=”Y”>'%1A'</textPattern>
    </dataSetId>
```

This example shows a search for all granules whose **dataSetId** is either 'LEAF CHEMISTRY, 1992-1993 (ACCP)' or 'ASTER DEM Product V002’.

```
    <dataSetId>
      <list>
        <value>'LEAF CHEMISTRY, 1992-1993 (ACCP)'</value>
        <value>'ASTER DEM Product V002'</value>
      </list>
    </dataSetId>
```

6.3.4 OnlineOnly

Use **OnlineOnly** to search for granules or collections that are available online.

```
    <onlineOnly/>
```

6.3.5 ECHO Insert Date

Use **ECHOInsertDate** to specify a search for collections or granules based on their insertion date into ECHO. You can only specify a dateRange.

```
  <ECHOInsertDate>
    <dateRange>
      <startDate>
        <Date YYYY="2001" MM="04" DD="05"/>
        // endDate is not required
      </startDate>
    </dateRange>
  </ECHOInsertDate>
```

6.3.6 ECHO Last Update

Use **ECHOLastUpdate** to specify a search for collections or granules based on the date of their last update within ECHO. You can only specify a dateRange.

```
  <ECHOLastUpdate>
    <dateRange>
      <startDate>
        <Date YYYY="2001" MM="01" DD="01"/>
      </startDate>
      <stopDate>
        <Date YYYY="2001" MM="06" DD="01"/>
      </stopDate>
    </dateRange>
```

```
</ECHOLastUpdate>
```

6.3.7 Sensor Name

Use **sensorName** to search for collections or granules based on the name of the sensor. You can search for a known value in a **value**, a list of known values in a **list**, or a text pattern in a **textPattern**. You can specify the relationship between each value with the Boolean "AND" or "OR".

- The "AND" relationship means that results must match every value specified.
- The "OR" relationship means that results must match either or both of the values specified. "OR" is the default setting for searching with multiple values.

```
<granuleCondition>
  <sensorName operator="AND">
    <list>
      <value>'human observer'</value>
      <value>'rain gauge'</value>
    </list>
  </sensorName>
</granuleCondition>
```

6.3.8 Instrument Short Name

Use **instrumentShortName** to search for collections or granules based on the name of the instrument. You can search for a known value in a **value**, a list of known values in a **list**, or a text pattern in a **textPattern**. You can specify the relationship between each value with the Boolean "AND" or "OR".

- The "AND" relationship means that results must match every value specified.
- The "OR" relationship means that results must match either or both of the values specified. "OR" is the default setting for searching with multiple values.

```
<granuleCondition>
  <instrumentShortName operator="AND">
    <list>
      <value>'GPS'</value>
      <value>'Telescope'</value>
    </list>
  </instrumentShortName>
</granuleCondition>
```

6.3.9 Source Name

Use **sourceName** to search for collections or granules based on the name of the source. You may specify the name using a **value**, a list of known values in a **list**, or a text pattern in a **textPattern**. You can specify the relationship between each value with the Boolean "AND" or "OR".

- The "AND" relationship means that results must match every value specified.
- The "OR" relationship means that results must match either or both of the values specified. "OR" is the default setting for searching with multiple values

```
<granuleCondition>
  <sourceName operator="AND">
```

```
      <list>
        <value>'CV-580'</value>
        <value>'C-130'</value>
      </list>
    </sourceName>
  </granuleCondition>
```

6.4 Spatial

Pull most of this out to a separate section

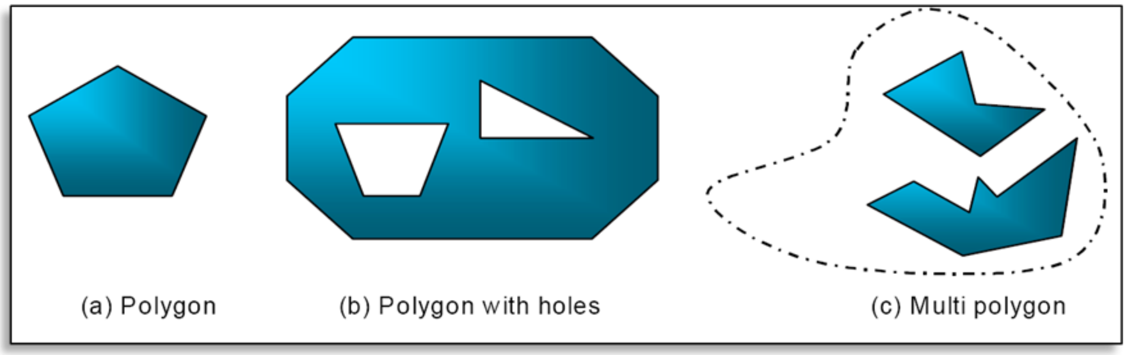
Use spatial constraints to restrict the search within a spatial extent of the earth. Specify the spatial extent using the elements **IIMSPolygon**, **IIMSMultiPolygon**, **IIMSBox** or **IIMSLine**.

You may also specify a **TwoDCoordinate** element along with a spatial element in a spatial constraint. This is useful when you wish to find spatially coincident granules between collections that support **TwoDCoordinate** searches and those that do not. When you use **TwoDCoordinate** together with a spatial element, ECHO will return all granules that satisfy either the **TwoDCoordinate** constraint or the spatial element, or both. You may only use **TwoDCoordinate** in a spatial constraint for granule (inventory) queries, not collection queries.

You may also use **TwoDCoordinate** outside of a spatial constraint. In this case, list **TwoDCoordinate** inside a **granuleCondition**. ECHO will return results that satisfy the **TwoDCoordinate** constraint and all other conditions (including any spatial conditions if they are present).

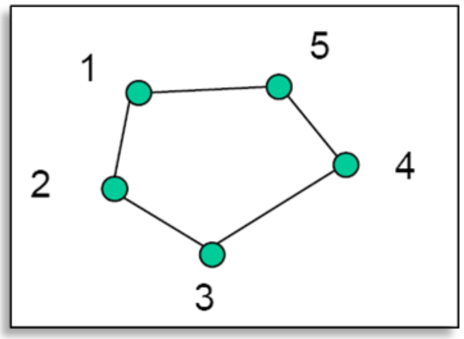
A **Polygon** consists of one or more rings. Some rings may be embedded within others that define the interior of the polygon. *The ECHO system can handle polygons with only one external ring and multiple internal rings.*

Figure 6: Allowed Geometries for Spatial Data and Query Windows



To define a ring, the last point in the ring must be the same as the first point in the ring. You must specify the points in each polygonal ring in counterclockwise order.

Figure 7: Order of Points in a Polygonal Ring



To specify multiple outer rings, use the **MultiPolygon** or **IIMSMultiPolygon** element, with each outer ring in a separate **Polygon**. There should be no overlap between any of the outer rings defined. Refer to Code Listing 19: A Multi-Polygon Spatial Query for examples.

Use **IIMSBox** to specify a bounding box on the Earth. A bounding box contains two points. The first point is the lower left corner of the box. The second point is the upper right corner of the box. The horizontal lines of the box will follow the latitude lines of the earth. This means the points of the box will not connect by lines following great circle arcs but will curve to stay at the same latitude.

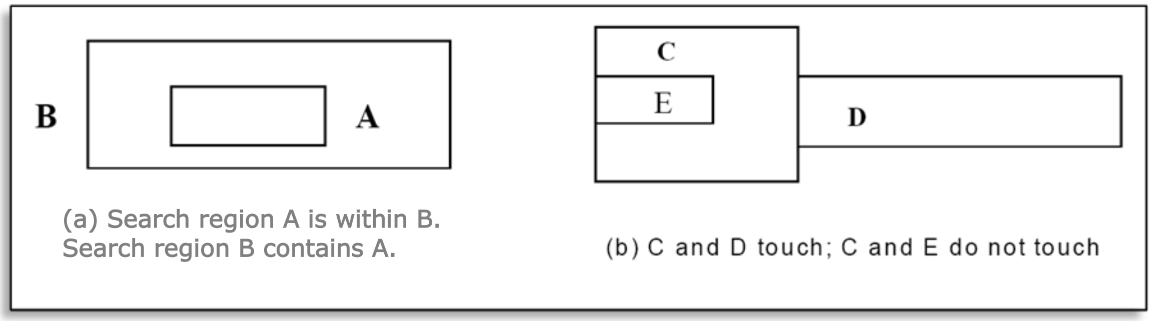
Use **IIMSLine** or **LString** to specify a line on the Earth. You must specify the points in the line from one endpoint to the other. You can also use **IIMSPoint** to specify a single point on the Earth. Note that although **IIMSPoint** is used to describe corner points in a polygon or endpoints in a line, it also describes a specific searchable geometry. Refer to Code Listing 20: A Single Point Spatial Query and for examples.

The table below describes Spatial Operators available in the ECHO System, regarding the relationship between two objects.

Table 6: Spatial Operators

Spatial Operator	Description
EQUAL	They have the same boundary and interior.
TOUCH	The boundaries intersect but the interiors do not.
WITHIN	Interior and boundary of the first object are completely contained in the interior of the second.
CONTAINS	The interior and boundary of the second object are completely contained in the interior of the first.
RELATE	The objects are non-disjoint, that is, their bodies and/or boundaries intersect.

Figure 8: Examples of Spatial Regions


B
A
(a) Search region A is within B.
Search region B contains A.
C
E
D
(b) C and D touch; C and E do not touch

Define the query so that the user-specified spatial extent is the second object in the query.

- Use **CONTAINS** to retrieve granules/collections that contain the specified polygon.
- Use **WITHIN** to retrieve granules/collections that are within the specified spatial extent.
- Use **RELATE** to retrieve granules/collections that overlap in some way. **RELATE** is the default operator.

ECHO supports multiple spatial representations (or SpatialTypes). Spatial data of different spatial representations are described differently and hence are stored and queried differently.

The **SpatialType** tag is an optional field in AQL used to specify the spatial type. If the user opts not to specify this field, ECHO performs a default search. By default, ECHO performs the search on **NORMAL** (Cartesian and Geodetic), and **ORBIT**.

Code Listing 18: Spatial Search Element

```
<spatial operator="RELATE">
```

```
    <IIMSPolygon>
      <IIMSLRing>
        <IIMSPoint lon="-120" lat="-30" />
        <IIMSPoint lon="-100" lat="-60" />
        <IIMSPoint lon="5" lat="-90" />
        <IIMSPoint lon="-120" lat="-60" />
        <IIMSPoint lon="160" lat="5" />
        <IIMSPoint lon="160" lat="60" />
        <IIMSPoint lon="120" lat="85" />
        <IIMSPoint lon="5" lat="85" />
        <IIMSPoint lon="-120" lat="30" />
        <IIMSPoint lon="-120" lat="-30" />
      </IIMSLRing>
      <IIMSLRing>
        <IIMSPoint lon="80" lat="20" />
        <IIMSPoint lon="80" lat="60" />
        <IIMSPoint lon="20" lat="60" />
        <IIMSPoint lon="20" lat="20" />
        <IIMSPoint lon="80" lat="20" />
      </IIMSLRing>
    </IIMSPolygon>
    <TwoDCoordinateSystem>
      <TwoDCoordinateSystemName>
        <value>'WRS2'</value>
      </TwoDCoordinateSystemName>
      <Coordinate1><range lower='15' upper='20'/></Coordinate1>
      <Coordinate2><range lower='33' upper='42'/></Coordinate2>
    </ TwoDCoordinateSystem>
  <SpatialType>
      <list>
        <value>NORMAL</value>
        <value>ORBIT</value>
      </list>
    </SpatialType>
  </spatial>
```

6.4.1 Spatial Type: NORMAL

Conventional spatial data are described as shapes such as polygons, multi-polygons, boxes, or lines. NORMAL is the spatial type to use for searching this type of data. Spatial data are stored in the database as Oracle objects to record the shape, spatial locations, and coordinate system used; i.e., Cartesian or Geodetic.

All spatial objects with the exception of Box in AQL, ECHO interprets as Geodetic. Geodetic spatial data has some restrictions. The total area of a single polygon cannot exceed half the earth. Lines, either alone or in a polygon, cannot be longer than half the circumference of the earth.

The same points in Cartesian and Geodetic describe two different areas. Great circle arcs connect points in Geodetic. These follow the shortest paths on the earth between two points. Latitude lines connect points in Cartesian. The image below shows a geodetic area Google Earth below as a red outlined polygon overlayed over a white polygon representing the Cartesian area described with the same points.

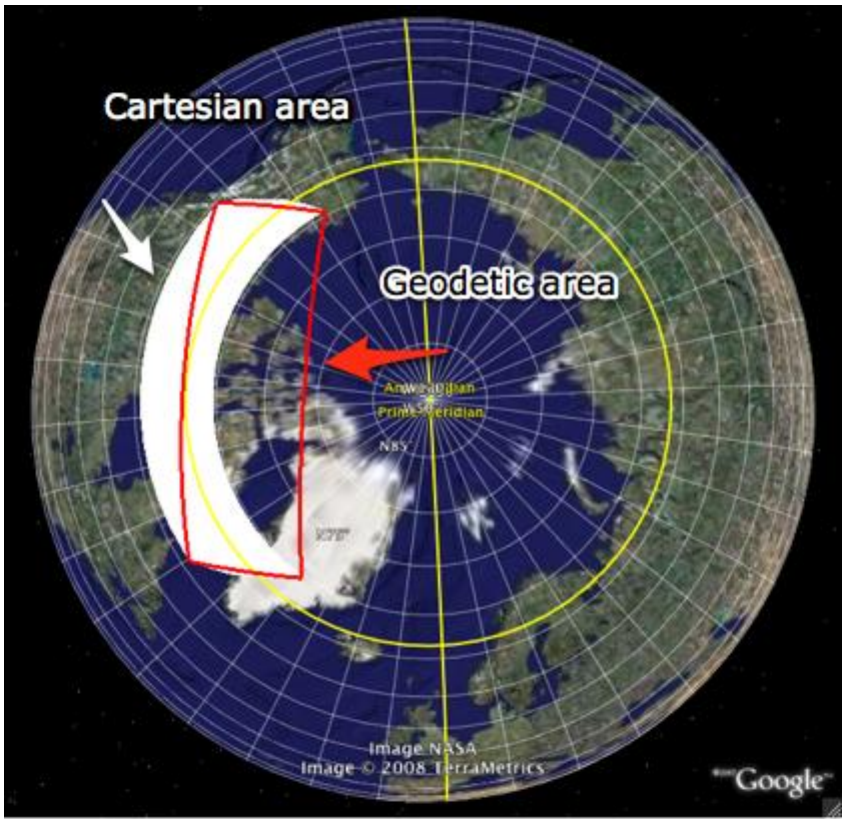


Figure 9: Spatial differences between a Geodetic area and a Cartesian Area

As noted previously, Geodetic and Cartesian represent polygons in different ways. There are other differences though besides how the lines define the shape. These differences stem from the fact that Geodetic and Cartesian are different representations of the earth. Geodetic is an ellipsoidal model of the earth whereas Cartesian describes the surface of the earth as a flat plane.

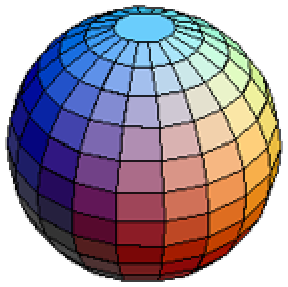


Figure 10: Ellipsoid

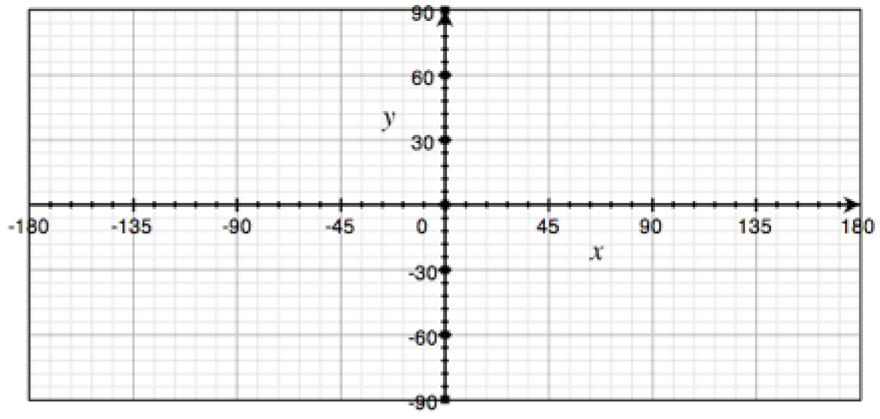


Figure 11: Flat Cartesian plane

These fundamental differences lead to some polygons being valid in Geodetic and not valid in Cartesian. Polygons and lines follow Geodesics so ECHO uses them as-is for searching geodetic data. Boxes, on the other hand, follow the latitude lines of the earth so ECHO uses them as-is for searching Cartesian data. ECHO converts polygons and lines from Geodetic for searching the Cartesian data and converts boxes from Cartesian when searching Geodetic data. The converted areas are valid approximations of the original areas. ECHO performs the conversion first by dividing the spatial area into pieces so that each new area fits within the bounds of sections of the earth. ECHO uses eight octants when converting from Geodetic to Cartesian. ECHO uses four quadrants when converting from Cartesian to Geodetic. The Cartesian graph below shows the octant bounds. ECHO divides the spatial area so that it does not cross the antimeridian, the prime meridian, or either of the poles.

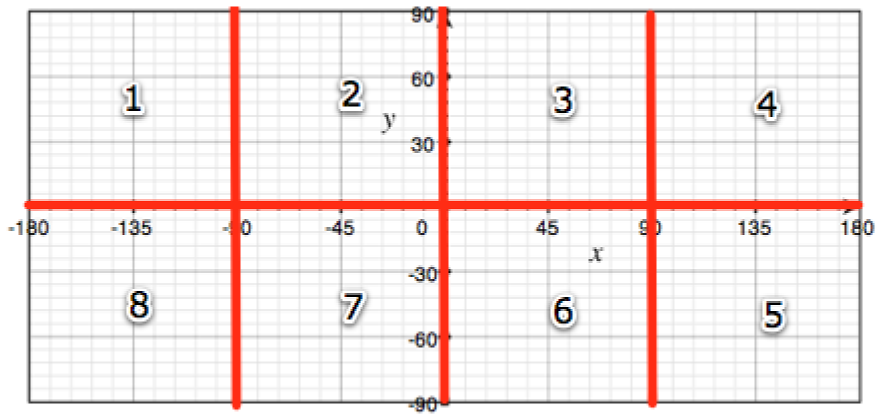


Figure 12: Bounds of the eight octants

After dividing the spatial area, the lines of the spatial area are "densified". Densification means that ECHO adds more points along the lines between the original points. This has the effect of making the lines in Cartesian space approximate the lines in geodetic space and vice versa. ECHO adds points every 10 km during densification. We found this number to be a good compromise between performance and accuracy. It is important that client developers understand ECHO uses an approximation of the area so in a small number of cases there may be some missed or extra results. Images, shown below, illustrate the Geodetic to Cartesian Conversion process.

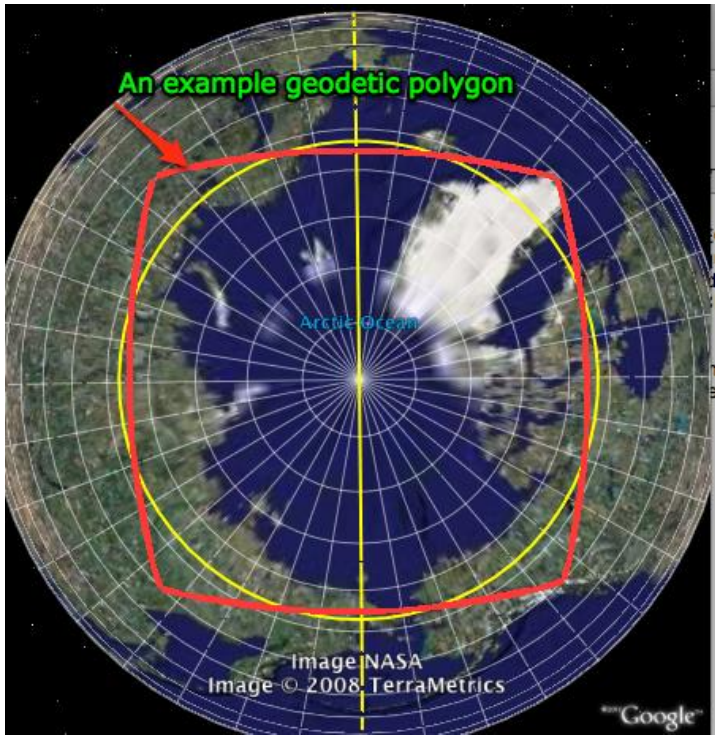


Figure 13: Example geodetic polygon

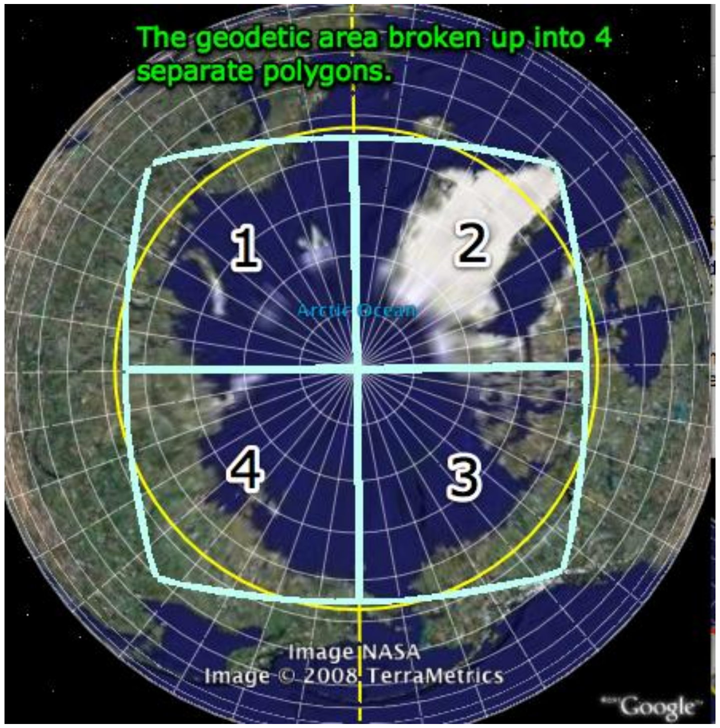

The geodetic area broken up into 4 separate polygons.
1
2
3
4
Arctic Ocean
Image NASA
Image © 2008 TerraMetrics
Google

Figure 14: Geodetic polygon divided by octants

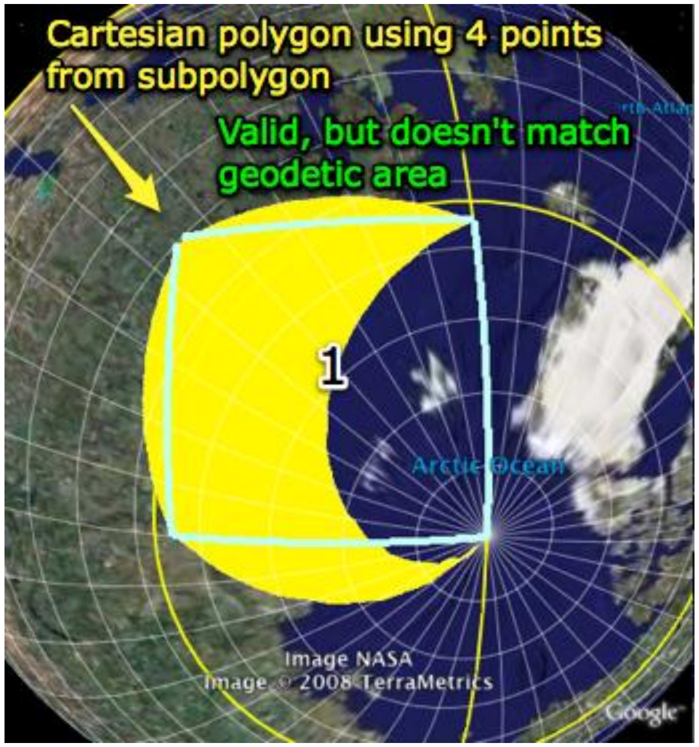

Cartesian polygon using 4 points from subpolygon
Valid, but doesn't match geodetic area
1
Arctic Ocean
Image NASA
Image © 2008 TerraMetrics
Google

Figure 15: Cartesian polygon before densification

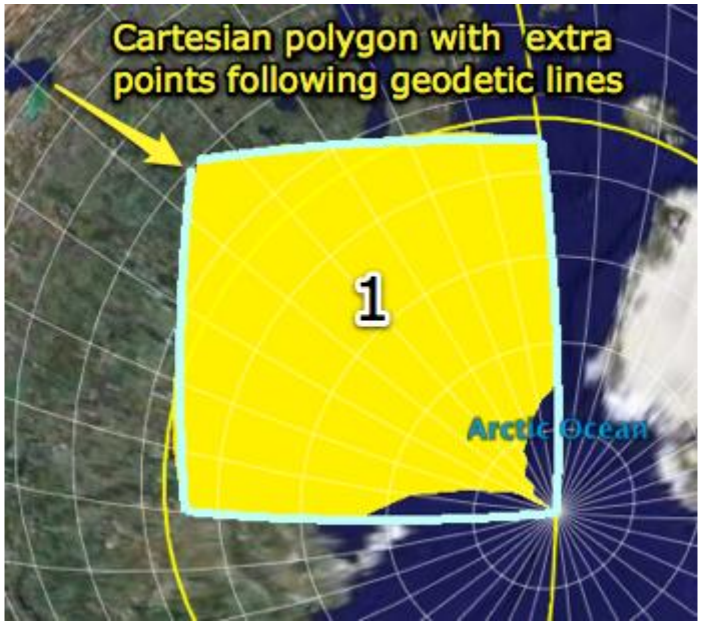

Cartesian polygon with extra points following geodetic lines
1
Arctic Ocean

Figure 16: Cartesian polygon after densification

6.4.2 Spatial Type: ORBIT

Spatial data are orbit-based and generated from satellites running along orbits. Because an orbit travels at a fixed direction with a fixed declination angle and the covered area is a stripe of fixed width, the spatial coverage of a granule can be derived from the latitude where the granule starts and ends and the crossing longitude on the equator where its orbit originally starts. Thus, the orbit-based spatial data are not stored as shape objects but as the original data. ECHO uses an algorithm called “Backtrack” to perform searches on orbit-based data. Spatial coverage can be as large as the entire earth surface including polar area. ECHO does simple validation against the spatial window to make sure it does not exceed the scope of the earth (the latitude is within the range –90 to 90 and the longitude is within the range –180 to 180).

There is one limitation in the current implementation: the only supported spatial operator is **RELATE**. With ECHO 10.0, multi-orbit as well as single orbit searches are supported.

This example shows a multi-polygon spatial query.

Code Listing 19: A Multi-Polygon Spatial Query

```
<spatial operator='RELATE'>
  <IIMSMultiPolygon>
    <IIMSPolygon>
      <IIMSLRing>
        <IIMSPoint lat="85" long="-50"/>
        <IIMSPoint lat="70" long="-60"/>
        <IIMSPoint lat="60" long="-50"/>
        <IIMSPoint lat="70" long="-40"/>
        <IIMSPoint lat="85" long="-50"/>
      </IIMSLRing>
    </IIMSPolygon>
    <IIMSPolygon>
      <IIMSLRing>
        <IIMSPoint lat="-85" long="-50"/>
        <IIMSPoint lat="-70" long="-40"/>
        <IIMSPoint lat="-60" long="-50"/>
        <IIMSPoint lat="-70" long="-60"/>
        <IIMSPoint lat="-85" long="-50"/>
      </IIMSLRing>
    </IIMSPolygon>
  </IIMSMultiPolygon>
</spatial>
```

NOTE: Refer to Figure 6: Allowed Geometries for Spatial Data and Query Windows for an example of an image of a multi-polygon.

This example shows a single point spatial query.

Code Listing 20: A Single Point Spatial Query

```
<spatial operator='RELATE'>
  <IIMSPoint long='-75.0' lat='35.0'/>
</spatial>
```

6.5 Temporal

Use temporal constraints to specify the temporal extent of the data. The dates are stored as Gregorian dates, and the times are stored in GMT. This search allows only dates in YYYY-DD-MM format. You can specify a range of time represented by beginning and ending dates or a periodic temporal range specified by start date and end date. For a periodic temporal range, you can specify the start and end day of each year. You should use integers between 1 and 365 to specify the start and end dates, with start day =< end day. You can specify the end day as 366, *but* if the temporal range contains a non-leap year, then an error will be generated.

This example shows a search for granule/collections whose temporal range overlaps with the time between May 12, 1990, and June 13, 1992.

Code Listing 21: Temporal Search Example

```
<temporal>
  <startDate><Date YYYY="1990" MM="5" DD="12"/></startDate>
  <stopDate><Date YYYY="1992" MM="6" DD="13"/></stopDate>
</temporal>
```

This example shows a search for granules/collections whose temporal range overlaps with all of these time ranges:

- May 16 - July 14, 1990
- January 5 - March 5, 1991
- January 5 - February 10, 1992

Code Listing 22: Temporal Example with Different Day Notations

```
<temporal>
  <startDate><Date YYYY="1990" MM="5" DD="12"/></startDate>
  <stopDate><Date YYYY="1992" MM="2" DD="10"/></stopDate>
  <startDay value="5"/>
  <endDay value="60"/>
</temporal>
```

6.5.1 Version ID

Use **versionId** to search for collections or granules based on the version identifier of the data collection. You can search for a known value in a **value**, a list of known values in a **list**, or a text pattern in a **textPattern**. As of ECHO 10.0, versionId is stored as a string so that it may look like 3,0033,0 ….

Code Listing 23: Version ID in a Collection Condition

```
  <versionId>
    <value>'0'</value>
  </versionId>
```

Code Listing 24: Version ID in a Granule Condition with a Pattern

```
<versionId>
<textPattern operator="LIKE">'3.%'</textPattern>
</versionId>
```

6.5.2 Additional Attributes

Use **additionalAttributes** to search for collections or granules based on one or many groups of the additional attributes by specifying the additional attribute name/value pair for an exact match. This function includes searching on multiple additional attributes. You may specify the relationship between groups with either "AND" or "OR".

- The "AND" relationship means that result granules must match across every group.
- The "OR" relationship means that result granules match with any of the specified groups. "OR" is the default setting.

Within each additional attribute, you must specify an **additionalAttributeName** in *single quotation marks (that is, apostrophes)* for an exact match. You may specify the **additionalAttributeValue** using **value**, **list**, **textPattern**, **range**, or **dateRange**.

This example shows the "AND" relationship between two additional attribute groups. You can use this sample search with either **granuleCondition** or **collectionCondition**.

Code Listing 25: Additional Attributes Example with an AND Relationship

```
<additionalAttributes operator='AND'>
  <additionalAttribute>
    <additionalAttributeName>
      'AveragedFocalPlane1Temperature'
    </additionalAttributeName>
    <additionalAttributeValue>
      <range lower='169' upper='170'/>
    </additionalAttributeValue>
  </additionalAttribute>
  <additionalAttribute>
    <additionalAttributeName>
      'AveragedFocalPlane2Temperature'
    </additionalAttributeName>
    <additionalAttributeValue>
      <range lower='269' upper='270'/>
    </additionalAttributeValue>
  </additionalAttribute>
</additionalAttributes>
```

This example shows the "OR" relationship between two additional attribute groups.

Code Listing 26: Additional Attribute Example with an OR Relationship

```
<additionalAttributes operator='OR'>
  <additionalAttribute>
    <additionalAttributeName>
      'AveragedFocalPlane1Temperature'
    </additionalAttributeName>
    <additionalAttributeValue>
      <range lower='169' upper='170'/>
    </additionalAttributeValue>
  </additionalAttribute>
  <additionalAttribute>
    <additionalAttributeName>
      'AveragedFocalPlane2Temperature'
    </additionalAttributeName>
    <additionalAttributeValue>
```

```
        <range lower='269' upper='270'/>
      </additionalAttributeValue>
    </additionalAttribute>
  </additionalAttributes>
```

6.6 Search Elements for Collection/Discovery Queries

This section describes elements used specifically for collection (Discovery) searches.

6.6.1 Science Keywords

Use **scienceKeywords** to specify the science keywords associate with a collection. Science Keywords are based on the GCMD managed list of science keywords. They have the following hierarchical structure *Category > Topic > Term > Variable Level 1 > Variable Level 2 > Variable Level 3 > Detailed Variable.* A value at any of the specific hierarchy levels can be specified or *anykeyword* can be used to search all the levels. Science Keywords are all stored in upper case. Queries with science keywords will automatically be changed to upper case for searching.

If you specify a list or a single value, then the search looks for an exact match between the string specified and the data stored. For example, if the search value is 'IMAGERY' and the data stored has the value 'SATELLITE IMAGERY', the data will not be returned since there was no exact match. In this instance, it is more useful to use the **textPattern** element for the search.

Code Listing 27: Sample Science Keyword Search

```
<collectionCondition>
 <scienceKeywords operator="AND">
   <scienceKeyword>
     <categoryKeyword>
         <value>'category'</value>
     </categoryKeyword>
     <topicKeyword>
         <value>'topic'</value>
     </topicKeyword>
     <termKeyword>
         <value>'term'</value>
     </termKeyword>
     <variableLevel1Keyword>
         <value>'level1'</value>
     </variableLevel1Keyword>
     <variableLevel2Keyword>
         <value>'level2'</value>
     </variableLevel2Keyword>
     <variableLevel3Keyword>
         <value>'level3'</value>
     </variableLevel3Keyword>
     <detailedVariableKeyword>
         <value>'detailed'</value>
     </detailedVariableKeyword>
   </scienceKeyword>
 </scienceKeywords>
<collectionCondition>
```

Code Listing 28: Sample Science Keyword Search with anyKeyword

```
<collectionCondition>
 <scienceKeywords operator="AND">
   <scienceKeyword>
     <anyKeyword>
         <textPattern>'%WATER%'</textPattern>
     </anyKeyword>
   </scienceKeyword>
 </scienceKeywords>
<collectionCondition>
```

6.6.2 Processing Level

Use **processingLevel** to specify the level at which the data (collection/granule) has been processed, for example, level 0, 1, 1A, 1B, 2, 3, 4. The search can specify one or more processing levels. The values must be single-quoted strings.

This example shows a search for all collections at processing level 1, 1A, or 1B.

Code Listing 29: Processing Level Search Element

```
<collectionCondition>
  <processingLevel>
    <list>
      <value>'1'</value>
      <value>'1A'</value>
      <value>'1B'</value>
    </list>
  </processingLevel>
</collectionCondition>
```

This example shows a search for all collections at processing level 1, 1A, or 1B—any value starting with the digit 1. This also returns results for collections with processing levels 13, 14, etc.

Code Listing 30: Processing Level Element with Text Pattern

```
<collectionCondition>
  <processingLevel>
    <textPattern operator="LIKE">'1_'</textPattern>
  </processingLevel>
</collectionCondition>
```

6.6.3 Additional Attribute Name

Use **additionalAttributeName** to search for collections based on the names of the additional attributes in the collections. You can search for a known value in a **value**, a list of known values in a **list**, or a text pattern in a **textPattern**.

This example shows a search for data with an **additionalAttributeName** value of 1 or 3.

Code Listing 31: Additional Attribute Search Element

```
<collectionCondition>
  <additionalAttributeName>
    <list>
```

```
      <value>'value_1'</value>
      <value>'value_3'</value>
    </list>
  </additionalAttributeName>
</collectionCondition>
```

6.6.4 Short Name

Use **shortName** to specify a search for the short name of collections, which may or may not be unique for a particular provider.

This example shows a search for all collections that have shortNames starting with ‘BOREAS.’

Code Listing 32: Short Name Search Element

```
<collectionCondition>
  <shortName>
    <textPattern>'BOREAS%'</textPattern>
  </shortName>
</collectionCondition>
```

6.6.5 Spatial Keywords

Use **spatialKeywords** to specify a word or phrase that summarizes the spatial region covered by the collection. A collection may cover several regions.

This example shows a search for all collections that cover Africa or Bermuda or the Indian Ocean.

Code Listing 33: Spatial Keywords Search Element

```
<collectionCondition>
  <spatialKeywords>
    <list>
      <value>'Africa'</value>
      <value>'Bermuda'</value>
      <value>'Indian Ocean'</value>
    </list>
  </spatialKeywords>
</collectionCondition>
```

This example shows a search for all collections that cover some region(s) of the Americas.

Code Listing 34: Spatial Keywords Element with Text Pattern

```
<collectionCondition>
  <spatialKeywords>
    <textPattern operator="LIKE">'%america%'</textPattern>
  </spatialKeywords>
</collectionCondition>
```

6.6.6 Temporal Keywords

Use **temporalKeywords** to specify a word or phrase that summarizes the temporal characteristics referenced in the collection.

This example shows a search for all collections that have accumulated data during the spring or fall.

Code Listing 35: Temporal Keywords Element

```
<collectionCondition>
  <temporalKeywords>
    <list>
      <value>'spring'</value>
      <value>'fall'</value>
    </list>
  </temporalKeywords>
</collectionCondition>
```

6.6.7 Archive Center

Use **archiveCenter** to search for collections based on the center where a collection is archived. You may search for a known value in a **value**, a list of known values in a **list**, or a text pattern in a **textPattern**.

Code Listing 36: Archive Center Search Element

```
<collectionCondition>
  <archiveCenter>
    <value>'ORNL_DAAC'</value>
  </archiveCenter>
</collectionCondition>
```

6.7 Search Elements for Granule/Inventory Queries

This section describes elements used specifically for granule (Inventory) searches.

6.7.1 Granules with Browse Data

Use **browseOnly** to specify that you want only granules that have browse data available.

Code Listing 37: Browse-only Search Element

```
<granuleCondition>
  <browseOnly/>
</granuleCondition>
```

6.7.2 Percentage of Cloud Cover

Use **cloudCover** to specify a range of percentage of scene cloud coverage in a granule. For the value in each attribute of the range, you should use a floating number between 0 and 100 that specifies the range in percentage of cloud coverage in a granule. *You cannot use the negated condition for this search.*

This example shows a search for only those granules that have cloud cover between 10% and 20%.

Code Listing 38: Cloud Cover Search Element

```
<granuleCondition>
```

```
  <cloudCover>
    <range lower="10" upper="20"/>
  </cloudCover>
</granuleCondition>
```

6.7.3 Day, Night, or Both Granules

Use **dayNightFlag** to specify a search for granules that are gathered during daylight only, nighttime only, or both. If you do not specify this criterion, then your results will include granules gathered at all times of day.

This example shows a search for granules gathered at least partly during daylight.

Code Listing 39: Search Element for Granules Gathered During Daylight Only

```
<granuleCondition>
  <dayNightFlag value="DAY"/>
</granuleCondition>
```

This example shows a search for granules gathered at least partly during the night.

Code Listing 40: Search Element for Granules Gathered During the Nighttime Only

```
<granuleCondition>
  <dayNightFlag value="NIGHT"/>
</granuleCondition>
```

This example shows a search for granules gathered partly at night and partly during the daylight.

Code Listing 41: Search Element for Granules Gathered During Daylight, Nighttime, or Both

```
<granuleCondition>
  <dayNightFlag value="Both"/>
</granuleCondition>
```

6.7.4 ECHO Granule IDs

Use **ECHOGranuleID** to specify an inventory search for specific granules. This search does not need to specify any spatial or temporal constraint. You can use this as a second stage query when you know the list of granules you are interested in from a previous query to hone results. The search is then limited to granules in the list. The list may contain granules from different data sets. ECHO performs the search on ECHO_GRANULE_ID, an ECHO-wide unique ID. You must enclose the names of the granules in single quotation marks (that is, apostrophes).

Code Listing 42: Granule ID Search Element

```
<granuleCondition>
  <ECHOGranuleID>
    <list>
      <value>'G1984-ORNL_DAAC'</value>
    </list>
  </ECHOGranuleID>
</granuleCondition>
```

6.7.5 Granule UR

Use **GranuleUR** to specify an inventory search for specific granules. Like granule ID, this criterion can be used as a secondary stage query. Instead of using the ECHO-specific ID for the granules, this criterion allows you to use the provider-given name for the granules. Provider-given names are more meaningful and easier to remember. Since the granule names given by the provider are not guaranteed to be unique within ECHO, if a granule with the same name exists for more than one **dataCenterId** specified in the query, all will be returned in the results. You must enclose the names of the granules in single quotation marks (that is, apostrophes). Note that the GranuleUR can contain value, list, textPattern or patternList children.

Code Listing 43: Granule UR Search Element

```
<granuleCondition>
  <GranuleUR>
    <list>
      <value>'ACCP_CANOPYCHEM.df_can_calc.dat'</value>
      <value>'ANGLIA_10YRCLIMATE.cfrs1120.zip'</value>
    </list>
  </GranuleUR>
</granuleCondition>
```

6.7.6 Two-Dimensional Coordinate System

Use **TwoDCoordinateSystem** as an alternative to specifying a spatial or temporal range. For some collections, granules can be located by searching a range of values on a two dimensional grid, (for example, Path/Row for Landsat, X/Y for MODIS Grid data).

The **TwoDCoordinateSystem** criterion needs three elements:

- the **TwoDCoordinateSystemName**
- the **Coordinate1** range
- the **Coordinate2** range

Coordinate1 and **Coordinate2** may also take a single value. The query returns all granules that match your specified TwoDCoordinateSystemName and overlap with the **Coordinate1** and **Coordinate2** ranges. **Coordinate1** and **Coordinate2** ranges must have both lower and upper attributes specified.

This example shows a search for a range value.

Code Listing 44: TwoDCoordinateSystem Search Element

```
<granuleCondition>
  <TwoDCoordinateSystem>
    <TwoDCoordinateSystemName>
      <value>'WRS2'</value>
    </TwoDCoordinateSystemName>
    <Coordinate1><range lower='15' upper='20'/></Coordinate1>
    <Coordinate2><range lower='33' upper='42'/></Coordinate2>
  </ TwoDCoordinateSystem>
</granuleCondition>
```

This example shows a search for a single value.

Code Listing 45: TwoDCoordinateSystem Search Element with a Single Value

```
<granuleCondition>
```

```
    <TwoDCoordinateSystem>
      <TwoDCoordinateSystemName>
        <value>'WRS2'</value>
      </TwoDCoordinateSystemName>
      <coordinate1><value>15<value/></coordinate1>
      <coordinate2><range lower='33' upper='42'/></coordinate2>
    </ TwoDCoordinateSystem >
  </granuleCondition>
```

6.7.7 ProducerGranuleID

Use **ProducerGranuleID** to specify an inventory search for specific granules. **ProducerGranuleID** represents the ID assigned to data by the Science team that produced the data. Instead of using the ECHO-specific IDs for the granules, this criterion allows the user to use the producer's given name for the granules. Granule names are available to the Science teams and are easier to search on. Since the granule names given by the producer are not guaranteed to be unique within ECHO, if a granule with the same name exists for more than one **dataCenterId** specified in the query, all will be returned in the results. You must enclose the names of the granules in single quotation marks (that is, apostrophes). Note that the ProducerGranuleID can contain value, list, textPattern or patternList children.

Code Listing 46: ProducerGranuleID Search Element

```
<granuleCondition>
  <ProducerGranuleID>
    <list>
      <value>'MOD03.A2000107.0930.003.2002056052717.hdf'</value>
      <value>'MOD01.A2000107.0740.003.2002056051321.hdf'</value>
    </list>
  </ProducerGranuleID>
</granuleCondition>
```

6.7.8 PGE Name

Use **PGEName** to search for granules based on the name of the product generation executive (PGE). You can search for a known value in a **value** element, a list of known values in a **list**, or a text pattern in a **textPattern**.

Code Listing 47: PGE Name Search Element

```
<granuleCondition>
  <PGEName>
    <value>'test_PGEName'</value>
  </PGEName>
</granuleCondition>
```

6.7.9 PGE Version

Use **PGEVersion** to search for granules based on the version of PGE that originally produced the granule. You can search for a known value in a **value** element, a list of known values in a **list**, or a text pattern in a **textPattern.**

Code Listing 48: PGE Version Search Element

```
<granuleCondition>
```

```
    <PGEVersion>
      <value>'3.0.0'</value>
    </PGEVersion>
  </granuleCondition>
```

6.7.10 Collection Short Name

Use **collectionShortName** to search for granules based on the short name of the collection they belong to. You can search for a known value in a **value** element, a list of known values in a **list**, or a text pattern in a **textPattern**.

Code Listing 49: Collection Short Name Search Element

```
  <granuleCondition>
    <collectionShortName>
      <value>'MOD03'</value>
    </collectionShortName>
  </granuleCondition>
```

6.7.11 Measured Parameters

Use **measuredParameters** to search for granules based on one or more groups of measured science parameters. You can specify the relationship between groups of parameters with either AND or OR.

- An AND relationship means that result granules must match across all groups.
- An OR relationship means that result granules can match any of the groups. OR is the default setting.

Within each measured parameter, you must specify a **measuredParameterName** in single quotation marks (that is, apostrophes) for exact matching. The detailed measured parameters can be **value**, **list**, and **textPattern** type, or **range** and **dateRange** type.

This example shows a search that specifies an "AND" relationship between two measured parameter groups.

Code Listing 50: Measured Parameter Search Element

```
  <granuleCondition>
    <measuredParameters operator="AND">
      <measuredParameter>
        <measuredParameterName>
          'EV_1KM_RefSB'
        </measuredParameterName>
        <operationalQualityFlag>
          <value>'Passed'</value>
        </operationalQualityFlag>
        <QAPercentOutOfBoundsData>
          <range lower='30' upper='40'/>
        </QAPercentOutOfBoundsData>
      </measuredParameter>
      <measuredParameter>
        <measuredParameterName>
          'EV_1KM_RefSB'
        </measuredParameterName>
        <operationalQualityFlag>
          <value>'Passed'</value>
        </operationalQualityFlag>
        <QAPercentOutOfBoundsData>
          <range lower='39' upper='50'/>
        </QAPercentOutOfBoundsData>
      </measuredParameter>
    </measuredParameters>
  </granuleCondition>
```

This example shows a search that specifies an "OR" relationship between two measured parameter groups.

Code Listing 51: Measured Parameter Search Element

```
<granuleCondition>
  <measuredParameters operator="OR">
    <measuredParameter>
      <measuredParameterName>
        'EV_1KM_RefSB'
      </measuredParameterName>
      <operationalQualityFlag>
        <value>'Passed'</value>
      </operationalQualityFlag>
      <QAPercentOutOfBoundsData>
        <range lower='30' upper='40'/>
      </QAPercentOutOfBoundsData>
    </measuredParameter>
    <measuredParameter>
      <measuredParameterName>
        'EV_1KM_RefSB'
      </measuredParameterName>
      <operationalQualityFlag>
        <value>'Passed'</value>
      </operationalQualityFlag>
      <QAPercentOutOfBoundsData>
        <range lower='39' upper='50'/>
      </QAPercentOutOfBoundsData>
    </measuredParameter>
  </measuredParameters>
</granuleCondition>
```

6.7.12 ProviderInsertDate

Use **providerInsertDate** to search for granules that are within a desired date-time range. **StartDate** is a required field, and **StopDate** is optional. The **Date** format is:

```
<Date YYYY="2001" MM="01" DD="01" HH="00" MI="00" SS="00"/>
```

Where YYYY is year; MM is month, DD is day of the month; HH is hour; MI is minute, and SS is second.

This example shows a search using **providerInsertDate**.

Code Listing 52: Provider Insert Date Search Element

```
<granuleCondition>
  <providerInsertDate>
    <dateRange>
      <startDate>
        <Date YYYY="2001" MM="01" DD="01" HH="00" MI="00" SS="00"/>
      </startDate>
      <stopDate>
        <Date YYYY="2003" MM="12" DD="01" HH="23" MI="59" SS="59"/>
      </stopDate>
    </dateRange>
  </providerInsertDate>
</granuleCondition>
```

6.7.13 ProviderProductionDate

Use **ProviderProductionDate** to search for granules that are within a desired date-time range. **StartDate** is a required field, and **StopDate** is optional. The **Date** format is:

```
<Date YYYY="2001" MM="01" DD="01" HH="00" MI="00" SS="00"/>
```

Where YYYY is year; MM is month, DD is day of the month; HH is hour; MI is minute, and SS is second.

This example shows a search of the Data Provider's production date search element.

Code Listing 53: Provider Production Date Search Element

```
<granuleCondition>
  <providerProductionDate>
    <dateRange>
      <startDate>
        <Date YYYY="2001" MM="01" DD="01" HH="00" MI="00" SS="00"/>
      </startDate>
      <stopDate>
        <Date YYYY="2003" MM="12" DD="01" HH="23" MI="59" SS="59"/>
      </stopDate>
    </dateRange>
  </providerProductionDate>
</granuleCondition>
```

6.8 Miscellaneous Elements

Use the following elements to search for other elements using AQL.

6.8.1 List

Use **List** to specify a list of values. The values may be numbers, dates, or strings. Each individual value must appear as text of the value element. If you specify a list of strings, you must use a single-quoted string with no wild-card characters. ECHO searches the parent element using Oracle's IN operator for an exact match with any value in the list.

In general, interpretation of the list will be dependent on the parent element in which it appears.

Code Listing 54: The List Element

```
<list>
  <value>'Africa'</value>
  <value>'Bermuda'</value>
  <value>'Indian Ocean'</value>
</list>
```

6.8.2 Pattern List

Use **patternList** to specify a list of text patterns and/or values. See section 6.8.4 for rules associated with values and section 6.8.3 for rules associated with text patterns.

The values may be numbers, dates, or strings. Each individual value must appear as text of the value element. If you specify a list of string values, you must use a single-quoted string with no wild-card characters.

The text patterns must conform to the rules specified in section 6.8.3.

ECHO searches the parent element using Oracle's IN operator for an exact match with any value in the list.

In general, interpretation of the list will be dependent on the parent element in which it appears.

```
<patternList>
  <value>'Africa'</value>
  <textPattern operator="LIKE" caseInsensitive=”Y”>'america%'</textPattern>
  <value>'Indian Ocean'</value>
</patternList>
```

6.8.3 Text Pattern

Use **textPattern** to search using the Oracle operator “LIKE” to perform pattern matching. Because of pattern matching, exact specification of what is desired is not needed. The code listing below shows how to invoke the pattern matching. Note that you must specify the operator, and you must use a single-quoted string with or without wild-card characters.

The wild-card characters supported are '%' and '_'. The character ‘%’ is a placeholder that represents any number of characters. The character “_” is a placeholder that represents a single character.

Table 7: AQL Wildcard Use

Wildcard pattern	Interpretation
‘%JOHN%’	Strings containing ‘JOHN’ as a sub-string
‘MARY%’	Strings beginning with the characters ‘MARY’
‘%BOB’	Strings ending in ‘BOB’
‘D_VE’	Strings like ‘DAVE’, ‘DOVE’, etc.

You can include the actual characters "%" or "_" in the pattern by using the ESCAPE character '\'. If the escape character appears in the pattern before the character "%" or "_", then Oracle interprets this character literally in the pattern, rather than as a special pattern-matching character.

Table 8: Wildcard Examples with ESCAPE Character

Wildcard pattern with ESCAPE character	Interpretation
‘JOHN\%THAN’	String ‘JOHN%THAN’
‘JOHN%THAN’	Strings ‘JOHNNATHAN’, ‘JOHNASDTHAN’, etc.
‘JOHN\\MARY’	String ‘JOHN\MARY’

If the parent element (**collectionCondition** or **granuleCondition**) has the attribute negated with value 'Y', then the search will look for a string NOT like the pattern specified.

Code Listing 55: Text Pattern Element

```
<spatialKeywords>
```

```
  <textPattern operator="LIKE" caseInsensitive="Y">'america%'</textPattern>
</spatialKeywords>
```

6.8.4 Value

Use **value** to specify one value. Refer to each individual parent element for a detailed explanation. In general, if the element represents a string pattern, the search will be case sensitive unless the **caseInsensitive** attribute is set to Y.

```
<value>12.6</value>
```

or

```
<value caseInsensitive="Y">'Asx'</value>
```

6.8.5 Date

Use **Date** to specify a date value.

```
<Date YYYY="2000" MM="05" DD="03"/>
```

or

```
<Date YYYY="2000" MM="10" DD="09" HH="21" MI="04" SS="32"/>
```

6.8.6 Date Range

Use **dateRange** to specify a range of time. The range can include just a **startDate**, just a **stopDate** or both. If you only include a **startDate**, ECHO searches for data from that time forward with no stop date. If you only include a **stopDate**, ECHO searches for data from the current time up until the stop date. If you include both a **startDate** and a **stopDate**, then ECHO searches for data falling between those two dates, for example, between January 1, 2005 and January 31, 2005.

```
<dateRange>
  <startDate><Date YYYY="2005" MM="01" DD="01"/></startDate>
  <stopDate><Date YYYY="2005" MM="01" DD="31"/></stopDate>
</dateRange>
```

or

```
<dateRange>
  <stopDate>
    <Date YYYY="2000" MM="10" DD="09" HH="04" MI="12" SS="34"/>
  </stopDate>
</dateRange>
```

6.8.7 DifEntryId

Use **DifEntryId** to find collections by their GCMD (Global Change Master Directory) DIF (Directory Interchange Format) Entry-ID. You can find the GCMD at the following URL: http://gcmd.nasa.gov.

CHAPTER 7. ORDERING DATA THROUGH ECHO

After identifying data of interest through catalog queries, you may place an order for that data if the data provider(s) allow it. ***To create an order, it is critical that you understand the parts that make up an order***.

An order is a collection of **order items**. Each order item consists of:

- The GUID for the catalog item you wish to order
- The quantity of the item you wish to order
- Other options associated with the item

Many catalog items belonging to many different providers may comprise a single order. Each provider may have its own validation scheme and rules for creating, validating, and submitting their particular catalog items. To ensure appropriate validation – as well as to demarcate a larger order for sending to each provider – orders are split up into smaller **provider orders**, sometimes called sub-orders. Each provider order includes all the order items in a particular order that belong to a specific provider. Each provider order has its own provider order GUID, a unique identifier comprised of the GUID of the provider and the GUID of the order that contains the catalog items for this provider. The following figure shows the structure of an order.

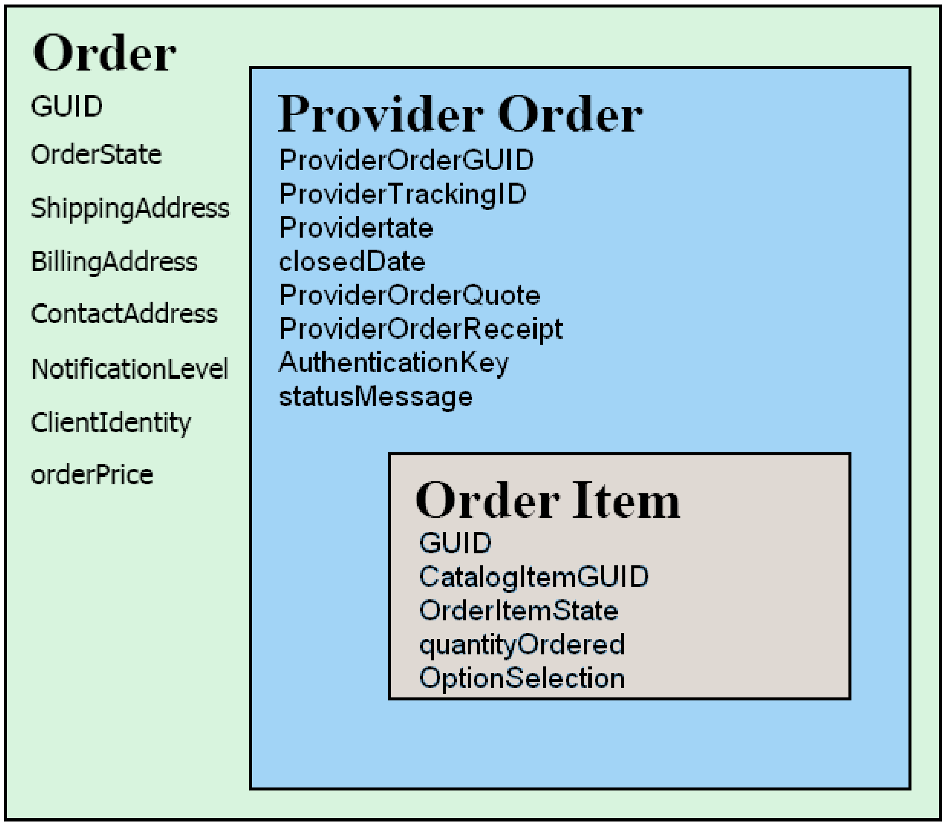


Figure 17: ECHO Order Structure

ECHO is designed to support a variety of providers and their various ordering needs, which brings some complexity to the process of order creation. The following figure illustrates the most commonly used and direct approach for creating and submitting an order.

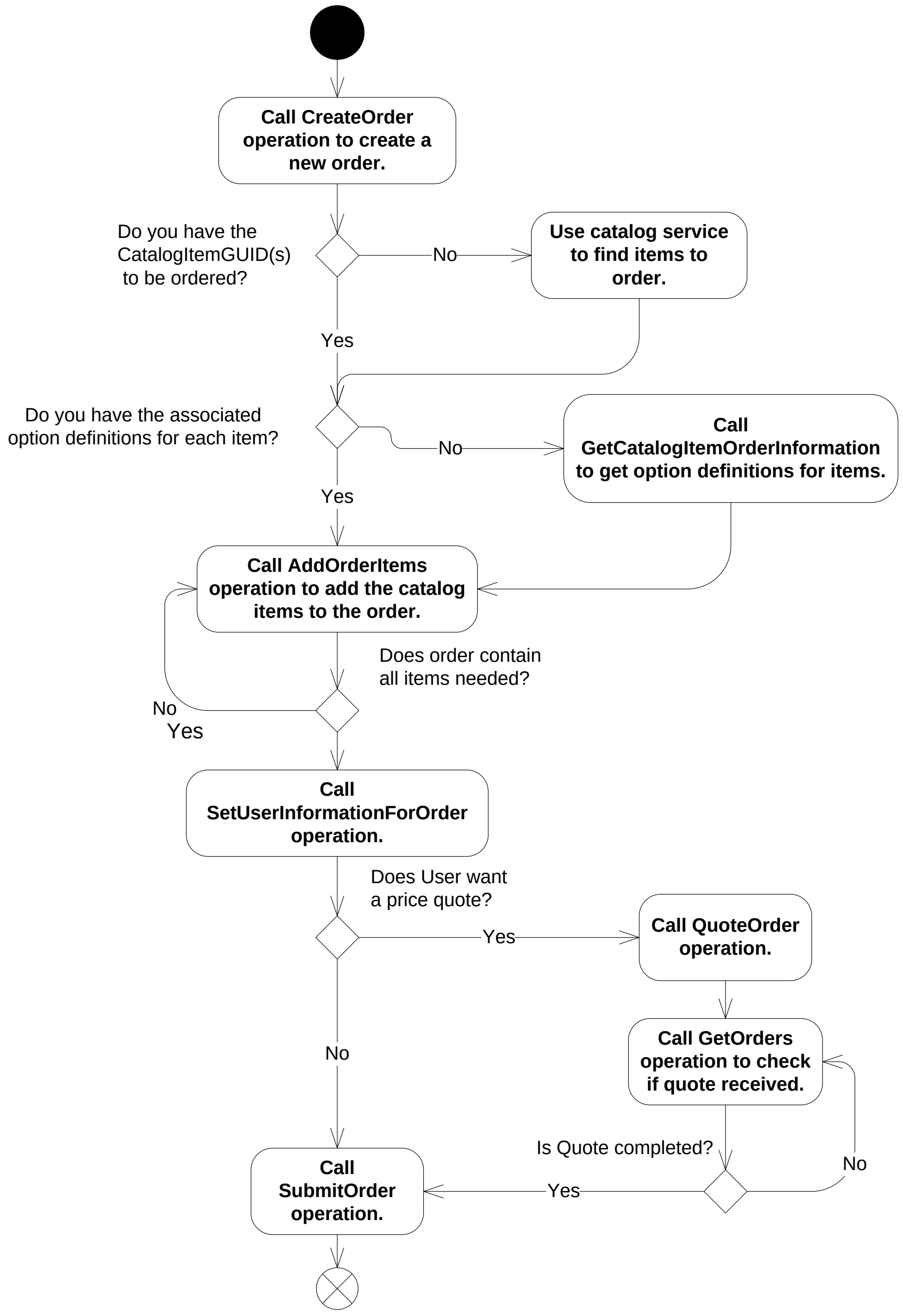

Call CreateOrder operation to create a new order.
Do you have the CatalogItemGUID(s) to be ordered?
No
Use catalog service to find items to order.
Yes
Do you have the associated option definitions for each item?
No
Call GetCatalogItemOrderInformation to get option definitions for items.
Yes
Call AddOrderItems operation to add the catalog items to the order.
Does order contain all items needed?
No
Yes
Call SetUserInformationForOrder operation.
Does User want a price quote?
Yes
Call QuoteOrder operation.
Call GetOrders operation to check if quote received.
No
Is Quote completed?
No
Yes
Call SubmitOrder operation.

Figure 18. The General Order Workflow

The most common way to obtain the catalog items needed for creating an order is through the **ExecuteQuery** operation found in the Catalog Service. You can also specify how the results should be displayed. When doing so, ensure that the **CatalogItemID** tag is returned. The string value under this tag is the actual catalog item GUID that you can use to order items from ECHO.

7.1 Order Options

Order Options use ECHO Forms (refer to http://www.echo.nasa.gov/data_partners/data_**tools10**.shtml for more information) for providers to indicate additional information required from users in order to fulfill their orders, such as the media to put the ordered data on and the specific subset of the data to order. Providers assign Order

Option definitions to catalog items. When you add an order item to an order that has required order options, it must contain an option selection that corresponds to one of the assigned option definitions for the catalog item you are ordering. *See section 1.3 of the ECHO Forms Specification for more details.*

To list the possible options for each catalog item, use the **GetCatalogItemOrderInfomation** operation on the **OrderManagementService**. The operation returns one object called **CatalogItemOrderInformation**. This contains a list of catalog items and a list of option definitions. Not every option definition in the list applies to every catalog item returned. Each catalog item is associated with zero or more option definition GUIDs, which will be included in the list returned in **CatalogItemOrderInformation**. Use only one selection from one of the definitions when you add a catalog item to the order. Use your discretion when choosing the definition to use for the order and the selection from within that definition.

*Note: Sometimes a catalog item may not be orderable; **GetCatalogItemOrderInformation** will return an exception if any catalog item is not orderable.*

Note: Not all catalog items have associated definitions, in which case they do not need option selections when ordering. However, if there are any options that are required by a catalog item, you are required to fill them out before you can validate and/or submit the order, or else an error will be returned.

The code listing below shows an example of getting the order options for two granules.

Code Listing 56: Getting Order Options for a Catalog Item

```
String token = "[token obtained from login]";

// The items we're interested in
String[] catalogItemGuids = new String[] { "G12345-PROV1", "G23456-PROV1" };

// Get the service
OrderManagementServiceLocator locator = new
    OrderManagementServiceLocator();
OrderManagementServicePort orderService =
        locator.getOrderManagementServicePort();

// Get the order information
CatalogItemOrderInformation itemInfo =
        orderService.getCatalogItemOrderInformation(token, catalogItemGuids);
```

Note: In order to utilize the new description and sort key option definition fields introduced during ECHO 10.1, clients must use the new complimentary operations. New operations are identified with the number 2, e.g. GetCatalogItemOrderInformation2 utilizes the new OptionDefinition2 type. See the ECHO Web Services API documentation for all instances.

7.2 Creating an Order

Once you have collected the catalog item GUIDs and associated options, you can create an order by calling the **CreateOrder** operation on the **OrderManagementService**. Simply pass an array of item IDs to add to the order.

7.2.1 Common Selection

If you are adding one or more items to an order at the same time, and their selections are the same, you can choose a common selection for the **CreateOrder**, **AddOrderItems**, **CreateAndSubmitOrder**, and

UpdateOrderItems operations that will be applied to all order items passed in without an option selection. This reduces the amount of data transmitted to ECHO and is less resource-intensive because ECHO will need to validate the common selection only once.

For each item in the array, you should set the following parameters:

Table 9: Parameters on a Catalog Item

Parameter	Description
ItemGuid	The catalog item GUID from the item's metadata
QuantityOrdered	The quantity of the item you want to order
OptionSelection	Option selection that matches one of the option definitions associated with this item. If no required option definitions are associated with the item, this will be an empty list.

The other attributes of Order Item should be empty when creating an order; ECHO will populate them automatically. ECHO will process the request and return a GUID identifying the newly created order. The code listing below shows an example of creating a simple order.

Code Listing 57: Creating a Simple Order

```
OrderItem[] orderItems = new OrderItem[2];
orderItems[0] =
        new OrderItem(null, null, "G12345-PROV1", null, (short) 2, null);
orderItems[1] =
        new OrderItem(null, null, "G23456-PROV1", null, (short) 2, null);
String orderGuid = orderService.createOrder(token, orderItems,null);
```

7.2.2 Adding Order Items

Once you have created an order, you may add other items to it using the **AddOrderItems** operation. This operation uses the GUID of the target order and a list of items to add. As with **CreateOrder**, the options other than those listed in the table above should be empty; ECHO will process the additions and return a list of GUIDs identifying these additions. The code listing below shows an example of adding items to an existing order.

Code Listing 58: Adding Items to an Existing Order

```
orderItems[0] =
        new OrderItem(null, null, "G34567-PROV1", null, (short) 2, null);
orderItems[1] =
        new OrderItem(null, null, "G45678-PROV1", null, (short) 2, null);
orderService.addOrderItems(token, orderGuid, orderItems,null);
```

ECHO assigns each item in an order a GUID unique to that order. For example, adding the same granule to two different orders will produce two new GUIDs, one linking the granule to the first order and one linking the granule to the second order.

7.2.3 Updating Order Items

Once you have added an item to an order, you can modify the options or quantity by calling **UpdateOrderItems** and passing in the modified items. *In this case, you must fill in the GUID of each item since ECHO needs to find the original item in your order to update it.* To ensure you are updating the appropriate item with the correct information, follow these steps:

- Call **GetOrderItems** to populate the data.

- Modify the desired order items.
- Pass the results to **UpdateOrderItems**.

The code listing below shows an example of updating an existing item.

Code Listing 59: Updating an Item in an Order

```
NameGuid[] itemNames =
        orderService.getOrderItemNamesByOrder(token, orderGuid);
String[] orderItemGuids = new String[] { itemNames[0].getGuid() };
OrderItem[] items = orderService.getOrderItems(token, orderItemGuids);
items[0].setQuantityOrdered((short) 22);

orderService.updateOrderItems(token, items,null);
```

7.2.4 Removing Order Items

You may remove items from an order using the **RemoveOrderItems** operation as shown below:

Code Listing 60: Removing an Item from an Order

```
itemNames = orderService.getOrderItemNamesByOrder(token, orderGuid);
orderItemGuids = new String[] { itemNames[0].getGuid() };
orderService.removeOrderItems(token, orderItemGuids);
```

7.3 Removing Orders and Canceling Orders

To delete a specific provider order(s), use the **RemoveProviderOrders** operation. *You cannot delete orders that you have already submitted.* For post-submittal orders, a registered user can use the **CancelOrder** operation on the **OrderManagementService** to cancel an open order.

Guest orders cannot be deleted in the post-submittal phase; the **CancelOrder** operation will delete the entire order, including all associated orders.

7.4 Setting User Information for an Order

Every order must have its own user-specific information attached to it so that a data provider can process the order. Contact information, billing, and shipping addresses are all required as well as user domain and region. Each order is independent of other orders, so user information must be set up for each order created.

You may set up user information at any point in the order process prior to submission. User information is not required until you validate, quote, or submit the order. If the required information is not present at that time, you will receive an error. You can set up user information for an order by calling the **SetUserInformationForOrder** operation on the **OrderManagementService**.

7.5 Validating an Order

To ensure that an order is complete, with all the required options and user-associated information for that order filled out, ECHO validates all orders when submitted or quoted. If you attempt to submit an invalid order, you will receive an error message. Currently, the message reflects only the first validation error encountered; you need to fix the reported error and revalidate until the order is error-free. At this point, if you change any aspect of the validated order before finally submitting it, then the order will again require validation. To validate orders, call **SubmitOrder** or **QuoteOrder**. You can manually validate orders with the **ValidateOrder** operation in the **OrderManagementService**.

Keep in mind that running the **ValidateOrder** operation may return a validation error related to one of the many provider-specific validation rules, which may change over time. You should find the error messages complete enough to help you determine what aspects of the order you need to correct.

Note that validation errors can occur if the order specified does not exist, or does not belong to you.

7.6 Requesting a Quote for an Order

Requesting a quote is an optional step that not all providers support. A quoted order provides a binding price for the order as a whole. The binding quote response from each of the necessary providers may take a day or more to receive. You cannot make changes to an order while it is in the quoting process. If you make changes to the order subsequent to the receipt of a quote, the changes may invalidate the quoted price. You may request a quote from a provider by calling **QuoteOrder**.

7.7 Submitting an Order

Once you have fully validated an order and have made no subsequent changes to the order, submit the order to the system using the **SubmitOrder** operation in the **OrderManagementService**.

Specify your preference for receiving order status information using one of the **NotificationLevel** choices shown in Table 10: ECHO Order Notification Levels

Table 10: ECHO Order Notification Levels

Notification Level	Description
VERBOSE	The system will e-mail you all provider order state changes and status message updates. (See the next table for more on order state changes.)
DETAIL	The system will e-mail you provider order state changes only.
INFO	The system will e-mail you when a provider order is closed or canceled.
CRITICAL	The system will e-mail you if the order fails during submission or is rejected by the provider.
NONE	The system will not send e-mail.

If you do not specify any notification level for a registered user's order, ECHO will use your preference value. If you, as a registered user, have not set a preference value, the default value is **INFO**. The notification for all guests' orders is also **INFO**.

Once an order transmits to the system using the **SubmitOrder** operation, ECHO sends each provider order contained within your order to the appropriate provider. Each provider will decide whether to accept your provider order and how to process it.

7.7.1 Tracking and Canceling Orders

From this point on, you can track the status of an order using the **GetOrders** operation in the **OrderManagementService**. At any point before the order actually ships, you may request cancellation of the order through the **CancelOrder** operation. You can then use the **GetOrders** operation again to track whether you successfully cancelled the order.

When ECHO sends a request to a provider to quote, submit or cancel a particular order, both ECHO and that provider must have the same ID for that order. ECHO identifies the specific provider order by the ProviderOrderGUID (which is the combination of the provider GUID and the order GUID). However, the provider may also have its own ID system for tracking a particular provider order. As a solution, the provider order in ECHO also contains a provider-tracking ID. When the provider receives the request from ECHO, the provider has the option to accept the order GUID that ECHO has assigned to that provider order, or to provide ECHO with its own unique ID. If the provider does pass back its own unique ID as the provider-tracking ID, then ECHO will use that ID in addition to the normal ECHO ProviderOrderGUID to refer to this provider order. If the provider does not specify a tracking ID, then the provider order will be referenced using only the ECHO ProviderOrderGUID.

7.8 Order States

An order consists of zero or many provider orders. An order state is calculated based on the state of the individual provider orders that make up the order. The table below shows the order states for orders made up of zero or one provider order or of multiple provider orders having the same provider order state.

Table 11: Order States with 0 or 1 Provider Order

# of Provider Orders	Provider Order State	Order State
0	-	NOT_VALIDATED
1	-	Same as provider order state
	QUOTE_FAILED	QUOTED_WITH_EXCEPTIONS
	QUOTE_REJECTED	
	SUBMIT_FAILED	SUBMITTED_WITH_EXCEPTIONS
	SUBMIT_REJECTED	

7.8.1 Restricted or Deleted Order Items

Some catalog items you may order only with permission. Each provider sets the restrictions and permissions on catalog item ordering. Providers may also delete catalog items at any time. Restrictions can apply to individual users, groups of users or all users. If a catalog item is not available to you, executing the **CreateAndSubmitOrder, GetCatalogItemOrderInformation**, **CreateOrder**, or **AddOrderItems** operation with this catalog item will return an error message indicating that it is not an orderable item. If an item becomes unavailable after you have created an order, you will receive an error message when you invoke the **UpdateOrderItems**, **ValidateOrder**, **QuoteOrder**, or **SubmitOrder** operation on that order.

CHAPTER 8. METADATA SUBSCRIPTIONS

Ordering should be the next major topic

8.1 Using Metadata Subscriptions to Automate Queries

The subscription service is used to deliver metadata updates on one or more collections from specific providers from ECHO to the subscribers. Users can create or update subscriptions for collections, granules, both collections and granules, or all collections and the spatial condition that they are interested in. These conditions include the addition, update, or deletion of metadata by a provider. This capability can be extremely valuable for client developers, because it provides the opportunity to set up post-processing and data massaging that runs when new or changed metadata is delivered, to convert it into an application-specific form.

The three key questions in creating a subscription are:

- ***What dataset are you interested in?*** To determine what providers exist in the system, you can call the **GetProviderNames** operation on the Provider Service, passing null for the GUIDs. Additionally, the Catalog Service discovery mechanism retrieves the datasets currently stored in the metadata repository.
- ***What type of metadata from the dataset are you interested in?*** ECHO allows you to subscribe to collection-level metadata, granule-level metadata, or both. Collection metadata will rarely change whereas granule metadata will be frequently updated or created; most users choose to subscribe to granule metadata for this reason. Be aware that providers may also delete granule metadata from time to time.
- ***Where should ECHO send the metadata when it is updated?*** ECHO supports two methods of subscription delivery: FTP and e-mail. Due to security restrictions, ECHO requires all FTP deliveries to be transferred via passive mode. If delivery is not possible (because the FTP server is full or the mail server rejects the large file attachment), ECHO sends an e-mail notification to the subscriber. Consult your local administrator for more information on passive-mode transfers and file size limitations.

In addition to the basic subscription information listed above, you may provide an AQL query to the Subscription Service that will be executed on your behalf when your subscription is triggered. In this case, the results of your query are sent rather than the raw updated metadata.

Note that users can specify an expiration date for the subscription, whether the result should be compressed (only GZIP compression is implemented), a limit on the size (in megabytes) of what is sent to the user, a format type (defaulted to ECHO format type), the options to specify which attributes are to be included in the metadata update, and a mechanism for sending the metadata update.

8.2 Creating a Metadata Subscription

To create a metadata subscription, call **CreateSubscriptions** in the Subscription Service, and pass the detailed **MetadataSubscription** information as described in the API documentation. Note the subscription GUID should be null since you are requesting a new subscription be created. **CreateSubscriptions** will return a list of GUIDs to identify the newly created subscriptions. The GUIDs will be listed in the same order in which you supplied the **MetadataSubscription** information.

Code Listing 61: Creating a Basic Subscription

```
String token = "[token obtained from login]";

// Get the subscription service
SubscriptionServiceLocator locator = new
    SubscriptionServiceLocator();
SubscriptionServicePort subService =
    locator.getSubscriptionServicePort();

// The information we want to subscribe to
String providerGuid = "[provider guid obtained using
```

```
    ListAllProviders]";
String datasetName = "dataset name obtained through a query]";
String query = "[AQL query assembled to limit the data
    returned]";

// Filtering information
MetadataFilterInfo filterInfo = new MetadataFilterInfo(query, 5);
MetadataActionInfo actionInfo =
        new MetadataActionInfo(null, CompressionType.GZIP,
            SubscriptionUpdateType.COLLECTIONS_ONLY);

// Delivery information
DeliveryInfo deliveryInfo =
        new DeliveryInfo(DeliveryType.EMAIL,
            "example@example.org", null, null,
            20);
Calendar stopTime =
    Calendar.getInstance(TimeZone.getTimeZone("GMT"));
stopTime.add(Calendar.YEAR, 1);

// Package it up in a MetadataSubscription element
MetadataSubscription[] metadataSubscriptions = new
    MetadataSubscription[1];
metadataSubscriptions[0] =
        new MetadataSubscription(null, null, "Example Simple Subscription",
            providerGuid, datasetName, filterInfo, actionInfo, deliveryInfo,
           stopTime);

// Ask ECHO to create the subscription
String[] guids =
    subService.createSubscriptions(token, metadataSubscriptions);
```

*If you provide a temporal condition in an AQL query for your subscription, you must leave **NumberOfDays** empty in **MetadataFilterInfo**. Likewise, if you use **NumberOfDays**, you may not have a temporal constraint in your AQL.*

Each metadat subscription must have the following information:

Table 12: Metadata Subscription Information

Subscription Parameter	Description
Subscription Name	A unique name to describe this subscription. In ECHO 10.10, the name must be unique.
Provider GUID	The unique ID of the provider you wish to subscribe to. If you want to subscribe to all providers, you may use an asterisk (*) with constraints.
Dataset Name	The name of the dataset you wish to subscribe to or asterisk (*) to indicate all datasets from the selected provider(s).
Metadata Filter Info	The spatial and/or temporal constraint to use for the subscription to narrow the data to a specific geographic location or period(s) of time. The AQL query filter is used to specify an IIMS AQL condition when validating metadata updates specified in your subscription preferences. The temporal filter element is an integer that represents a specified number of days prior to today's date--that is, a span of days--that allows you to focus on

Subscription Parameter	Description
	data whose acquisition dates fall within that span. Note that you can only set the temporal filter either in the AQL TemporalCondition or in the NumberOfDays. It is an ERROR to set it in both.
Metadata Action Info	The information related to processing of the subscription. Like Query, you can limit the metadata fields returned by a subscription by specifying a list of MetadataAttributes.
Compression Type	The compression type to use on the metadata file. Note the subscription files delivered from ECHO are XML-formatted and highly compressible. It is recommended that you use a CompressionType of GZIP to conserve space and bandwidth.
Subscription Update Type	The type of metadata to subscribe to: • ALL_COLLECTIONS: You will receive all updated collection metadata. • COLLECTIONS_ONLY: You will receive all updated collection metadata from within your specified collection. • GRANULES_ONLY: You will receive all updated granule metadata from within your specified collection. • BOTH: You will receive both the updated collection metadata and the updated granule metadata from within your specified collection.
Delivery Info	The way in which metadata should be delivered from the subscription: EMAIL or FTPPUSH. If email is chosen, the DeliveryAddress should be of the format “username@domain”. If FTP Push is chosen, the DeliveryAddress should also be of the format “username@ftp.domain”. For FTP deliveries, the DeliveryFolder and Password fields are required. The Subscription Service has a governor that prevents delivery of metadata above a certain threshold. LimitSize is your specified maximum acceptable size (in megabytes) of the delivery file. The system calculates the size of the data file prior to delivery; if the size exceeds LimitSize, the file is not delivered.
StopTime	The time after which metadata should cease to be delivered.

8.3 Deleting a Subscription

To remove a subscription, call the **RemoveSubscriptions** operations with the GUIDs of the subscriptions to remove, as shown below.

Code Listing 62: Removing a Subscription

```
String[] subGuids = new String[] { "[subscription guid]" };
subService.removeSubscriptions(token, subGuids);
```

8.4 Listing Subscriptions

You can list the names and GUIDs of subscriptions using the **GetSubscriptionNames** and **GetSubscriptionNamesByState** operations.

Code Listing 63: Listing Subscriptions

```
subGuids = new String[] { "[subscription guid]" };
NameGuid[] allActiveNames =
    subService.getSubscriptionNames(token, null);
```

```
NameGuid[] specificActiveNames =
    subService.getSubscriptionNames(token, subGuids);

NameGuid[] allExpiredNames =
    subService.getSubscriptionNamesByState(token,
            SubscriptionState.EXPIRED);
```

Code Listing 64: Sample Granule Query Using Various Granule Conditions (Inventory)

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE query PUBLIC "-//ECHO CatalogService (v10)//EN"
"http://api.echo.nasa.gov/echo/dtd/IIMSAQLQueryLanguage.dtd">
<!--
Search for granules from the L70R or L70RWRS or GLCF_GRANULE_METADATA
datasets that have Browse data and were categorized as day granules.
-->
<query>
<for value="granules"/>
<dataCenterId>
  <list>
    <value>ORNL_DAAC</value>
  </list>
</dataCenterId>
<where>
  <granuleCondition>
    <browseOnly/>
  </granuleCondition>
  <granuleCondition>
    <cloudCover>
      <range lower="10" upper="20"/>
    </cloudCover>
  </granuleCondition>
  <granuleCondition>
    <dataSetId>
      <list>
        <value>'L70R'</value>
        <value>'L70RWRS'</value>
        <value>'GLCF_GRANULE_METADATA'</value>
      </list>
    </dataSetId>
  </granuleCondition>
  <granuleCondition>
    <dayNightFlag value="DAY"/>
    </granuleCondition>
  </where>
</query>
```

Code Listing 65: Sample Granule Query Using Spatial and Temporal Bounds (Inventory)

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE query PUBLIC "-//ECHO CatalogService (v10)//EN"
"http://api.echo.nasa.gov/echo/dtd/IIMSAQLQueryLanguage.dtd">
<!--
```

```
Search for granules the specified spatial region, and periodic temporal
extent
-->
<query>
<for value="granules"/>
<dataCenterId>
  <list>
    <value>ORNL_DAAC</value>
  </list>
</dataCenterId>
<where>
  <granuleCondition>
    <spatial operator="RELATE">
      <IIMSPolygon>
        <IIMSLRing>
          <IIMSPoint lon="-120" lat="-30" />
          <IIMSPoint lon="-100" lat="-60" />
          <IIMSPoint lon="-5" lat="-90" />
          <IIMSPoint lon="5" lat="85" />
          <IIMSPoint lon="-120" lat="30" />
          <IIMSPoint lon="-120" lat="-30" />
        </IIMSLRing>
        <IIMSLRing>
         <IIMSPoint lon="80" lat="20" />
         <IIMSPoint lon="80" lat="60" />
         <IIMSPoint lon="20" lat="60" />
         <IIMSPoint lon="20" lat="20" />
         <IIMSPoint lon="80" lat="20" />
        </IIMSLRing>
       </IIMSPolygon>
      </spatial>
    </granuleCondition>
  <granuleCondition>
    <temporal>
    <startDate><Date YYYY="1989" MM="01" DD="01"/></startDate>
    <stopDate><Date YYYY="1998" MM="12" DD="31"/></stopDate>
    <startDay value="1"/>
    <endDay value="300"/>
    </temporal>
  </granuleCondition>
  </where>
</query>
```

Code Listing 66: Sample Granule Query Using Sensor Name (Inventory)

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE query PUBLIC "-//ECHO CatalogService (v10)//EN"
"http://api.echo.nasa.gov/echo/dtd/IIMSAQLQueryLanguage.dtd">
<!--
Search for granules from ORNL_DAAC with source name SWIR or TIR
-->
<query>
<for value="granules"/>
<dataCenterId>
  <list><value>ORNL_DAAC</value></list>
```

```
</dataCenterId>
<where>
  <granuleCondition>
    <sensorName>
      <list>
        <value>'SWIR'</value>
          <value>'TIR'</value>
        </list>
    </sensorName>
  </granuleCondition>
  </where>
</query>
```

Code Listing 67: Sample Granule Query Using Temporal Constraints (Inventory)

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE query PUBLIC "-//ECHO CatalogService (v10)//EN"
"http://api.echo.nasa.gov/echo/dtd/IIMSAQLQueryLanguage.dtd">
<!--
Search for granules with temporal range: periodic range between Jan 1, 1990
and Dec. 31 1998 from the 1st to the 300th day
of each year.
-->
<query>
  <for value="granules"/>
  <dataCenterId>
    <list>
      <value>ORNL_DAAC</value>
    </list>
  </dataCenterId>
  <where>
    <granuleCondition>
      <temporal>
        <startDate>
          <Date YYYY="1990" MM="01" DD="01"/>
        </startDate>
        <stopDate><Date YYYY="1998" MM="12" DD="31"/></stopDate>
        <startDay value="1"/>
        <endDay value="300"/>
      </temporal>
    </granuleCondition>
  </where>
</query>
```

Code Listing 68: Sample Granule Query Using Additional Provider Specific Attributes (Inventory)

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE query PUBLIC "-//ECHO CatalogService (v10)//EN"
"http://api.echo.nasa.gov/echo/dtd/IIMSAQLQueryLanguage.dtd">
<query>
  <for value="granules"/>
  <dataCenterId>
    <value>ORNL_DAAC</value>
  </dataCenterId>
  <where>
    <granuleCondition>
      <additionalAttributes>
    <additionalAttribute>
        <additionalAttributeName>'COORDINATE_UNITS_NAME'</
additionalAttributeName>
        < additionalAttributeValue><value>'METERS'</value></
additionalAttributeValue>
   <additionalAttribute>
    </additionalAttributes>
    </granuleCondition>
  </where>
</query>
```

Code Listing 69: Sample Granule Query Using Additional Provider Specific Attributes with Complex Values (Inventory)

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE query PUBLIC "-//ECHO CatalogService (v10)//EN"
"http://api.echo.nasa.gov/echo/dtd/IIMSAQLQueryLanguage.dtd">
<query>
<for value="granules"/>
  <dataCenterId>
    <value>ORNL_DAAC</value>
  </dataCenterId>
  <where>
    <granuleCondition>
    <additionalAttributes>
      <additionalAttribute>
      <additionalAttributeName>'SAMPLE_DATE'</ additionalAttributeName>
      <additionalAttributeValue>
        <dateRange>
          <startDate>
            <Date YYYY="2000" MM="05" DD="12"/>
          </startDate>
          <stopDate>
            <Date YYYY="2000" MM="10" DD="12"/>
          </stopDate>
       </dateRange>
     </additionalAttributeValue>
   </additionalAttribute>
   </additionalAttributes>
   </granuleCondition>
  </where>
</query>
```

CHAPTER 9.   EVENT NOTIFICATION SERVICE

Event notification subscriptions allow third party applications to be notified by ECHO when an internal event occurs, such as a catalog modification (item added, removed, or updated) or an extended services modification (web service added, removed, or updated).

The event notification framework supports the delivery of the notifications in various ways, including FTP push, email, and a web service callback. The event notification API is custom to ECHO, however it is inspired by other WS standards such as WS-Eventing and WS-Notification.

The Event Notification Service allows you to manage Event Notification Subscriptions and delivery option. For information on using subscriptions to automate queries, including creating, deleting, and updating subscriptions, refer to Chapter 1, .

9.1 Event Subscriptions

Event notification subscriptions are represented by **EventSubscriptions**. An **EventSubscription** contains a:

a. **GUID**

b. **Name** (unique name for the subscription given by the user)

c. **EndTO** URL (optional URL where the notification that the subscription is ending abnormally will be sent)

d. **NotifyTo** URL (indicates where all notifications should be sent)

e. **DeliveryMode**

f. **Expires**

9.1.1 Delivery Modes

All events are delivered in a format described by the Event Schema. There are three delivery modes for event subscriptions. They are

- **Email**—as events occur, XML files conforming to the event schema will be sent as email attachments
- **FTP push**—ECHO uploads XML files of events to the FTP server you indicate
- **HTTPSOAP**—makes an HTTP SOAP web service call to the web service endpoint you give; web service must implement the Event Sink Service WSDL

9.1.2 Filtering Events

Event subscriptions may also optionally have a **Filter**. There are two kinds of **FilterDialects**.

- The **TOPIC** filter dialect filters events based on the event topic. Every event belongs to a specific topic. Multiple topics may be given by space delimiting them. See the API for the current topics that are supported.
- The **XPath** filter dialect allows events to be filtered by a Boolean XPath applied to the event XML. The event XML will conform to the Event Schema. If the XPath evaluates to true, the Event Notification will be sent. (XPath is a language for finding information in an XML document and navigating through elements and attributes—for more information, refer to Appendix D, ECHO Path URIs.)

9.1.3 Subscription Expiration

All subscriptions have a finite lifetime. An expiration date can be specified when the subscription is created or it will be given a default expiration date if it is not set. Events are NOT sent to the **EndTo** URL if the subscription expires normally.

9.1.4 Renewing Event Subscriptions

Event subscriptions can be renewed before they expire using the **RenewEventSubscriptions** operation, which will renew an event subscription until the given expiration date. The maximum duration of an event subscription is checked to ensure that the time of the Renew until the expiration date is not exceeded.

9.2 Creating Event Subscriptions

Event subscriptions can be created using the **CreateEventSubscriptions** operation. This allows multiple event subscriptions to be added at once. The GUID should be left empty as ECHO will populate this field internally. There are a maximum number of event subscriptions that are allowed to be created for a single user. If the subscription is invalid or the maximum has been reached, the operation will return a fault.

Code Listing 70: Creating an Event Subscription

```
EventNotificationServiceLocator eventNotificationServiceLocator =
    new EventNotificationServiceLocator();
EventNotificationServicePort eventNotificationService =
eventNotificationServiceLocator.getEventNotificationServicePort();

EventSubscription subscription = new EventSubscription();
subscription.setName("My Event Subscription");

// Notification will be through email
subscription.setDeliveryMode(NotificationDeliveryMode.EMAIL);
subscription.setNotifyTo(new URI("mailto:echotest@gst.com"));

// Filtering on provider and catalog events
subscription.setFilterDialect(FilterDialect.TOPIC);
subscription.setFilter("provider catalog");

String guid =
    eventNotificationService.createEventSubscriptions(userToken,
        new EventSubscription[] { subscription })[0];

System.out.println(subscription.getName() + " has been created");
```

9.2.1 Removing Event Subscriptions

Event subscriptions will eventually expire and be removed on their own, but they can also be removed manually using the **RemoveEventSubscriptions** operation. If an administrator removes the event subscription, then an event notification will be sent to the **EndTo** URL of the subscription if it has been set.

CHAPTER 10. INVOCATION SERVICE

The Invocation Service allows ECHO users to request that ECHO invoke an operation on a registered web service implementation enabling the brokering of services. A user specifies the implementation, operation, and parameters to a service, such as Event Notification Service, and ECHO will invoke the requested service.

ECHO tracks the invocations using an Invocation GUID. Requesting an invocation is an asynchronous operation.

10.1 Limitations

The sections below detail current limitations of the invocation service.

10.1.1 Primitive Type Arguments

The Invocation Service can only invoke operations that use primitive types (the basic XML schema primitive types such as “string” and “int”).

10.1.2 String Results

ECHO returns the results of an invocation as the type “string.”

10.1.3 Invocation State

ECHO stores the state of an invocation using the Status Service and the invocation GUID. The following is a list of the states an invocation can enter:

Table 13: Invocation States

Invocation State	Description
ACCEPTED	The invocation has been accepted by ECHO to be processed.
DELAYED	The invocation has been delayed by the service partner. A status annotation will list the date the invocation has been delayed until.
VALIDATING	ECHO is currently validating the invocation request.
PREPARING_DATA	ECHO is preparing data to perform the invocation.
PERFORMING_SERVICE	ECHO is currently invoking the operation.
PREPARING_RESULTS	The invocation has finished and ECHO is preparing the results of the invocation.
COMPLETE	The invocation is complete and the results are available.
ABORTED	The invocation has been aborted due to error. A status annotation will list the details of the error.

10.2 Client Operations

This text below lists the operations of the Invocation Service that are specifically intended for end users. Other operations for Service Partners, like **DelayInvocation** and **MarkAsynchronous,** are detailed in the “Invocation Service Aware Web Services” section on the following page. For more information about Service Partners, refer to the forthcoming *ECHO 10.10 Service Partner’s Guide*.

10.2.1 Invoke Operation

This operation submits a request to invoke an extended service operation. It is an asynchronous method so it returns an Invocation ID, used to track the progress of the invocation.

10.2.2 Arguments

The operations and parameters on a web service registered in ECHO can be retrieved using the **GetOperations** method on the Extended Services Service. The web service implementation GUID, operation name, and parameters are sent to this operation. The web service implementation GUID must be the GUID of an activated web service implementation registered in ECHO. The operation name is the name of the operation to invoke on the web service. The number and names of the parameters must be correct. The order of the parameters is not important since the names must be unique.

10.2.3 ECHO Path URI Parameters

If you want to use metadata of granules or collections as parameter values when invoking an operation, then you should use ECHO Path URIs. ECHO Path URIs map to the metadata of a granule or collection. If a parameter value is a URI of the correct format, the URI will be resolved and the value retrieved from the metadata will be sent when invoking the web service.

The type retrieved from the metadata must be convertible to the parameter type in the operation; otherwise, the invocation will be aborted. For example if a parameter takes a float and the ECHO Path URI resolves to “ABZ” then invocation will be aborted. See Appendix D, ECHO Path URIs for more information.

10.2.4 Returned Invocation GUID

The return value is an invocation GUID used to track the invocation. The invocation GUID is passed into all the other methods of the Invocation Service to specify the invocation to which the user is referring. As the invocation is processed, the status is set using the Status Service. The Transaction GUID used in the Status Service is the same as the Invocation GUID.

10.2.5 Get Results

This returns the last state of the invocation and the results if the invocation has completed. The last status will include the current state of the invocation and any annotations to that state. The results will be included if the invocation state is COMPLETE.

10.3 Service Partner Operations

Service Partners can create web services that are Invocation Service-aware to gain extra abilities and provide more value to end users when being invoked by ECHO. A service called the Invocation Utility Service enables an Invocation Service-aware web service to delay an invocation, add status information on the invocation, or indicate that the web service is asynchronous.

10.3.1 SOAP Header

Invocation Service-aware web services know they are being invoked by ECHO because a special SOAP Header is passed in the SOAP request to invoke the operation. The information passed is the invocation GUID and the URL to the Invocation Utility Service.

10.3.1.1 SOAP Header Layout

This lists the major elements of the ECHO invocation SOAP header. The namespace of all these elements is http://echo.nasa.gov/echotypes.

Table 14: Invocation SOAP Header Elements

Element	Description
EchoInvocation	This presence of this tag indicates this is an invocation by ECHO. It holds all of the information.
invocationId	This contains the invocation GUID that will be used on all the Invocation Utility Service methods.
invocationUtilityUrl	This contains the URL to the Invocation Utility Service.

10.3.1.2 SOAP Header Example

This shows an example of what the SOAP header passed during an invocation by ECHO will look like.

Code Listing 71: Invocation Service SOAP Header Example

```
<soapenv:Header>
<ns1:EchoInvocation
soapenv:actor="http://schemas.xmlsoap.org/soap/actor/next"
soapenv:mustUnderstand="0"
xmlns:ns1="http://echo.nasa.gov/echoTypes">
<ns1:invocationId
soapenv:actor="http://schemas.xmlsoap.org/soap/actor/next"
soapenv:mustUnderstand="0"
xsi:type="soapenc:string"
xmlns:soapenc="http://schemas.xmlsoap.org/soap/encoding/">
88A3BDFB-FDA3-4BA6-F3CE-92D052284503
</ns1:invocationId>
<ns1:invocationUtilityUrl
soapenv:actor="http://schemas.xmlsoap.org/soap/actor/next"
soapenv:mustUnderstand="0"
xsi:type="soapenc:string"
xmlns:soapenc="http://schemas.xmlsoap.org/soap/encoding/">
http://localhost:28000/echo_v8/InvocationUtilityService
</ns1:invocationUtilityUrl>
</ns1:EchoInvocation>
</soapenv:Header>
```

10.3.2 Invocation Utility Service

The Invocation Utility Service offers methods to Invocation-aware web services.

10.3.2.1 Delay Invocation

This operation delays the invocation until the specified date. This is useful if the web service does not currently have the resources available to process the invocation. ECHO will attempt to invoke the web service again at the specified date and time. See the section on Timing Concerns.

10.3.2.2 Set Status

This operation allows Invocation aware web services to provide detailed information to end users. The status string passed will be stored in ECHO under the current state of the invocation, which can be retrieved and viewed by users using the Invocation Service or Status Service.

10.3.2.3 Mark Asynchronous

This operation will mark the web service as being asynchronous. ECHO normally assumes when the operation returns that it is complete but if this operation is called, then the invocation state will stay in PERFORMING_INVOCATION until the web service notifies ECHO that it is complete using the Mark Complete operation. See the Timing Concerns section on timing concerns with this operation.

10.3.2.4 Mark Complete

This operation is used by asynchronous web services to notify ECHO that they are complete. The string results of the web service operation are an argument to this operation. Web services calling this method should have previously called the Mark Asynchronous operation.

10.3.2.5 Timing Concerns

When a web service being invoked by ECHO returns, ECHO normally assumes the invocation is complete and immediately marks it that way. If a web service wants to delay the invocation or mark it asynchronous, it must call the Delay Invocation and Mark Asynchronous operations before returning from the original invocation.

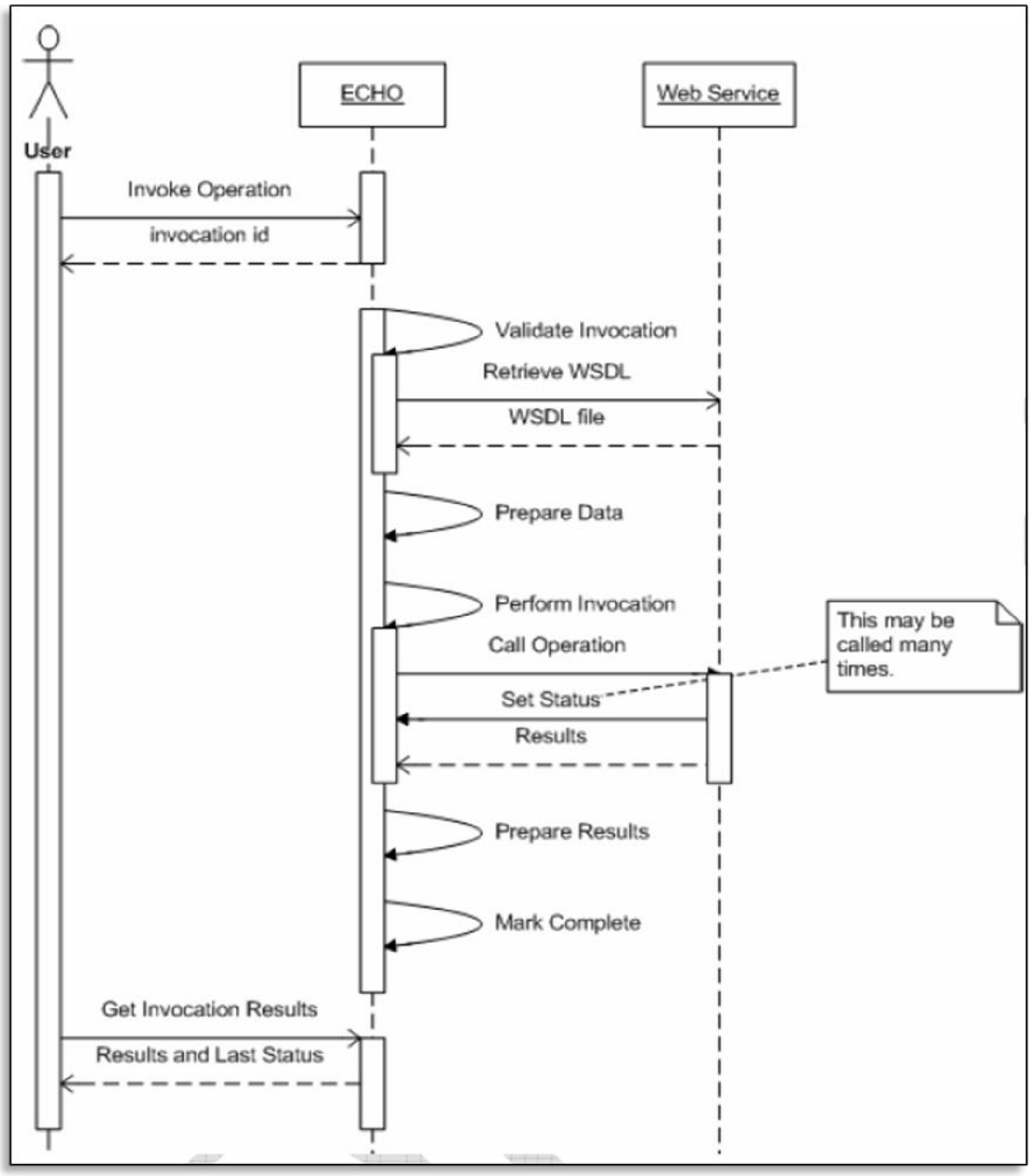
10.3.3 Invocation Sequence Diagrams

This contains some sequence diagrams showing the steps that happen during a regular and asynchronous invocation.

10.3.3.1 Normal Invocation Sequence Diagram

This diagram shows the normal sequence of steps when an invocation occurs.

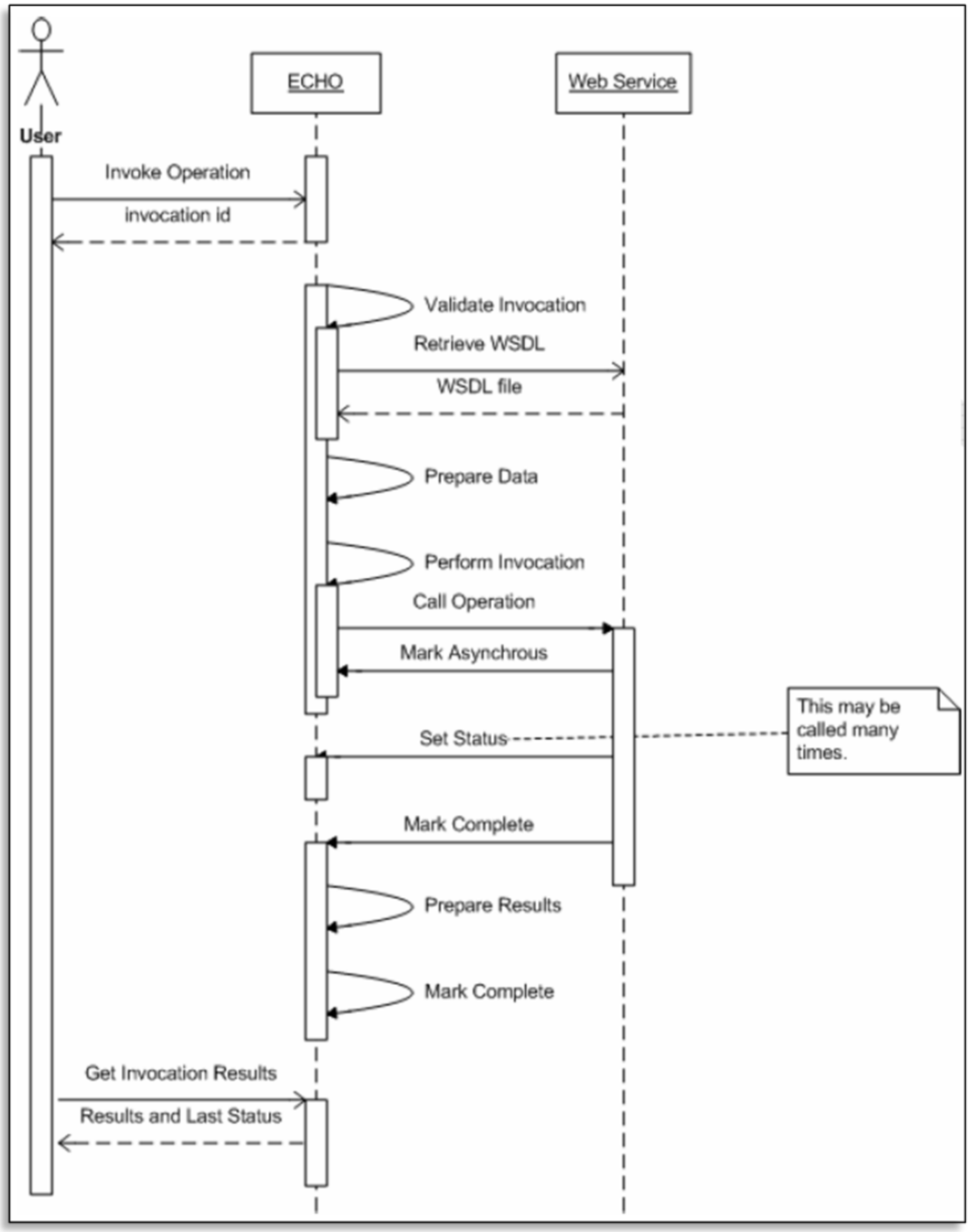
Figure 19: ECHO Invocation Service Sequence



10.3.3.2 Asynchronous Invocation Sequence Diagram

This diagram shows the sequence of steps when an invocation occurs on an asynchronous web service.

Figure 20: Asynchronous Invocation Sequence



APPENDIX A. ACRONYMS USED IN ECHO

Acronyms used in this document are contained in this appendix. A complete list of the acronyms frequently used in discussions of ECHO can be found on the ECHO website on the ECHO Acronyms page at http://www.echo.nasa.gov/overview/over_acronyms.shtml.

ACL	Access Control List
API	Application Programming Interface
AQL	Alternative Query Language
ASF DAAC	Alaska Satellite Facility DAAC
ASTER	Advanced Spaceborne Thermal Emission and Reflection Radiometer
BMGT	Bulk Metadata Generation Tool
COTS	Commercial Off The Shelf
DAAC	Distributed Active Archive Center
DB	DataBase
DTD	Document Type Definition
ECHO	EOS Clearinghouse
ECS	EOSDIS Core System
EDC	EROS Data Center
EDG	EOS Data Gateway
EJB	Enterprise JAVA Beans
EMD	EOSDIS Maintenance and Development
EOS	Earth Observing System
EOSDIS	EOS Data and Information System
EROS	Earth Resources Observation Systems
ESDIS	Earth Science Data and Information System
ESIP	Earth Science Information Partner
ETC	ECHO Technical Committee
FTP	File Transfer Protocol
GCMD	Global Change Master Directory
GES DAAC	GSFC Earth Sciences DAAC
GHRC	Global Hydrology Resource Center
GIS	Geographic Information System
GML	Geography Markup Language
GMT	Greenwich Mean Time
GSFC	Goddard Space Flight Center
GUI	Graphical User Interface

GUID	Globally Unique Identifier
IIMS	Independent Information Management Subsystem
J2EE	Java 2 Enterprise Edition
LAADS	Level 1 and Atmosphere Archive and Distribution System
LP DAAC	Land Processes DAAC
MISR	Multiangle Imaging SpectroRadiometer
MODIS	Moderate Resolution Imaging Spectroradiometer
NASA	National Aeronautics and Space Administration
NSIDC DAAC	National Snow and Ice Data Center DAAC
ODL	Object Description Language
OGC	OpenGIS Consortium
ORNL DAAC	Oak Ridge National Laboratory DAAC
PGE	Product Generation Executives
PO.DAAC	Physical Oceanography DAAC
PSA	Product Specific Attribute
PUMP	Provider User Management Program
QA	Quality Assurance
SEDAC	Socioeconomic Data and Applications Center
SOAP	Simple Object Access Protocol
SSC	Stennis Space Center
SSL	Secure Sockets Layer
UDDI	Universal Description, Discovery, and Integration
UI	User Interface
UR	Universal Reference
URI	Uniform Resource Identifier
URL	Uniform Resource Locator
UTC	Universal Time, Coordinated (also called GMT/UTC)
WIST	Warehouse Inventory Search Tool
WGS	World Geodetic System
WRS	Worldwide Reference System
WSDL	Web Services Description Language
XML	eXtensible Markup Language
XSLT	eXtensible Style Language Transformation

APPENDIX B. FUNCTIONAL BREAKDOWN BY USER/ROLE TYPE

Service/Transaction	Guest User	Registered User	Registered User with Data Provider Role	Registered User with Client Provider Role
AdministratorService				
GetAvailableMetricReports				
GetErrorMessages	√	√	√	√
GetMetricReports				
GetSecurityTokenInformation				
InitializeEchoSystemuser				
InitializeErrorCodes				
InitializeTaxonomies				
PurgeArchiveRecords				
RemoveMetricReports				
RemoveTokens				
RevokeAllTokensForUsers				
RevokeTokens				
SetErrorMessages				
SysncUddiRegistry				
AuthenticationService				
GetECHOVersion	√	√	√	√
GetSecurityTokenInformation				
login		√	√	√
logout		√	√	√
RemoveTokens				
RevokeAllTokensForUsers				
ReokeTokens				
CatalogService				
ExecuteQuery	√	√	√	√
GetCatalogItemMetadata	√	√	√	√
GetQueryResults	√	√	√	√

Service/Transaction	Guest User	Registered User	Registered User with Data Provider Role	Registered User with Client Provider Role
ResolveMetadataPaths			√	
DataManagementService				
All			√	
EventNotificationService				
All		√	√	√
ExtendedServicesService				
ActivateWSAdvertisements				
ActivateWSGuis				
ActivateWSImplementations				
ActivateWSInterfaces				
CreateWSAdvertisements				√
CreateWSGuis				√
CreateWSImplementations				√
CreateWSInterfaces				√
GetOperationsByImplementation	√	√	√	√
GetServiceNamesByTaxonomyEntry	√	√	√	√
GetWSAdvertisements	√	√	√	√
GetWSDLForWSInterface	√	√	√	√
GetWSGuis	√	√	√	√
GetWSImplementationNamesByWSInterface	√	√	√	√
GetWSImplementations	√	√	√	√
GetWSInterfaces	√	√	√	√
RemoveWSAdvertisements				√
RemoveWSGuis				√
RemoveWSImplementations				√
RemoveWSInterfaces				
UpdateWSAdvertisements				√
UpdateWSGuis				√
UpdateWSImplementations				√

Service/Transaction	Guest User	Registered User	Registered User with Data Provider Role	Registered User with Client Provider Role
UpdateWSInterfaces				
GroupManagementService				
CreateGroups			√	
GetGroupNames		√	√	√
GetGroupNamesByManager		√	√	√
GetGroupNamesByName		√	√	√
GetGroups		√	√	√
NotifyManagers		√	√	√
NotifyMembers		√	√	√
RemoveGroups (only group manager)		√	√	√
UpdateGroups (only group manager)		√	√	√
OrderManagementService				
AddOrderItems	√	√	√	√
CancelOrder	√	√	√	√
CancelProviderOrder	√	√	√	√
CreateAndSubmitOrder	√	√	√	√
CreateOrder	√	√	√	√
GetOrderItemNamesByOrder	√	√	√	√
GetOrderItemNamesByProviderOrder	√	√	√	√
GetOrderItems	√	√	√	√
GetOrders	√	√	√	√
GetProviderOrderGuidsByStateAndOwne r		√	√	√
GetProviderOrderGuidsByStateAndProvi der			√	√
GetProviderOrderGuidsByStateDateAnd Provider			√	√
QuoteOrder	√	√	√	√
RemoveOrderItems	√	√	√	√
RemoveOrders	√	√	√	√
RemoveProviderOrders	√	√	√	√
SetAuthenticationKey		√	√	√
SetUserInformationForOrder	√	√	√	√

Service/Transaction	Guest User	Registered User	Registered User with Data Provider Role	Registered User with Client Provider Role
SubmitOrder	√	√	√	√
UpdateOrderItems	√	√	√	√
ValidateOrder	√	√	√	√
OrderProcessingService				
All			√	
ProviderService				
ActivateProvider				
AddAuthenticatorDefinitions			√	
CreateProvider		√	√	√
GetAuthenticatorDefinitions	√	√	√	√
GetProviderNames	√	√	√	√
GetProviderPolicies			√	√
GetProviders	√	√	√	√
GetProviderSupportedTransactions	√	√	√	√
GetProviderNamesByProviderId	√	√	√	√
RemoveAuthenticatorDefinitions			√	
RemoveProviderPolicies			√	
SetProviderPolicies			√	
UpdateProvider			√	√
SubscriptionService				
All		√	√	√
TaxonomyService				
AddTaxonomyEntry				
CreateTaxonomy				
CreateVirtualTaxonomy				
GetRootPath	√	√	√	√
GetTaxonomies	√	√	√	√
GetTaxonomyEntries	√	√	√	√
GetTaxonomyEntry	√	√	√	√

Service/Transaction	Guest User	Registered User	Registered User with Data Provider Role	Registered User with Client Provider Role
UserService				
CreateAuthenticator		√	√	√
CreateUser	√			
GetAuthenticators		√	√	√
GetAuthenticatorNames		√	√	√
GetCurrentUser		√	√	√
GetUserNames		√	√	√
GetUserNamesByUserId		√	√	√
GetUserNamesByOrganizationAndFirstAndLastName			√	√
GetUserNamesByRole (provider role)			√	√
GetUserPreferences		√	√	√
GrantAccess (provider access)			√	
RecallUserId	√	√	√	√
RemoveAuthenticators		√	√	√
RemoveUserPreferences		√	√	√
RemoveUsers				
ResetUserPassword	√	√	√	√
RevokeAccess (provider access)			√	
SetUserPassword		√	√	√
SetUserPreferences		√	√	√
UpdateUser		√	√	√

APPENDIX C. JAVA-SPECIFIC INFORMATION

This appendix discusses one known issue and a solution for that issue.

C.1 Java: Axis Time-out Occurs While Calling Long Running Methods

Sometimes in operations that take longer than five minutes to perform, Axis times out. If this occurs, change the time-out on the service in Axis. In the code example below, the service retrieved from the service location must be cast to a Stub before calling **setTimeout** on it.

```
FServiceLocator loc = new FServiceLocator();
FServicePort service = loc.getFServicePort();
org.apache.axis.client.Stub s = (Stub) service;
s.setTimeout(timeInMillis);  // timeout is in milliseconds
```

APPENDIX D. ECHO PATH URIS

ECHO Path URI is the name given to a specific URI which maps into the metadata of a granule or collection. ECHO paths are based on XPath, a language for finding information in an XML document and navigating through elements and attributes. Refer to Chapter 8, Metadata Subscriptions

Ordering should be the next major topic

10.4 Using Metadata Subscriptions to Automate Queries

The subscription service is used to deliver metadata updates on one or more collections from specific providers from ECHO to the subscribers. Users can create or update subscriptions for collections, granules, both collections and granules, or all collections and the spatial condition that they are interested in. These conditions include the addition, update, or deletion of metadata by a provider. This capability can be extremely valuable for client developers, because it provides the opportunity to set up post-processing and data massaging that runs when new or changed metadata is delivered, to convert it into an application-specific form.

The three key questions in creating a subscription are:

- ***What dataset are you interested in?*** To determine what providers exist in the system, you can call the **GetProviderNames** operation on the Provider Service, passing null for the GUIDs. Additionally, the Catalog Service discovery mechanism retrieves the datasets currently stored in the metadata repository.
- ***What type of metadata from the dataset are you interested in?*** ECHO allows you to subscribe to collection-level metadata, granule-level metadata, or both. Collection metadata will rarely change whereas granule metadata will be frequently updated or created; most users choose to subscribe to granule metadata for this reason. Be aware that providers may also delete granule metadata from time to time.
- ***Where should ECHO send the metadata when it is updated?*** ECHO supports two methods of subscription delivery: FTP and e-mail. Due to security restrictions, ECHO requires all FTP deliveries to be transferred via passive mode. If delivery is not possible (because the FTP server is full or the mail server rejects the large file attachment), ECHO sends an e-mail notification to the subscriber. Consult your local administrator for more information on passive-mode transfers and file size limitations.

In addition to the basic subscription information listed above, you may provide an AQL query to the Subscription Service that will be executed on your behalf when your subscription is triggered. In this case, the results of your query are sent rather than the raw updated metadata.

Note that users can specify an expiration date for the subscription, whether the result should be compressed (only GZIP compression is implemented), a limit on the size (in megabytes) of what is sent to the user, a format type (defaulted to ECHO format type), the options to specify which attributes are to be included in the metadata update, and a mechanism for sending the metadata update.

10.5 Creating a Metadata Subscription

To create a metadata subscription, call **CreateSubscriptions** in the Subscription Service, and pass the detailed **MetadataSubscription** information as described in the API documentation. Note the subscription GUID should be null since you are requesting a new subscription be created. **CreateSubscriptions** will return a list of GUIDs to identify the newly created subscriptions. The GUIDs will be listed in the same order in which you supplied the **MetadataSubscription** information.

Code Listing 61: Creating a Basic Subscription

```
String token = "[token obtained from login]";

// Get the subscription service
SubscriptionServiceLocator locator = new
    SubscriptionServiceLocator();
```

```
SubscriptionServicePort subService =
    locator.getSubscriptionServicePort();

// The information we want to subscribe to
String providerGuid = "[provider guid obtained using
    ListAllProviders]";
String datasetName = "dataset name obtained through a query]";
String query = "[AQL query assembled to limit the data
    returned]";

// Filtering information
MetadataFilterInfo filterInfo = new MetadataFilterInfo(query, 5);
MetadataActionInfo actionInfo =
        new MetadataActionInfo(null, CompressionType.GZIP,
            SubscriptionUpdateType.COLLECTIONS_ONLY);

// Delivery information
DeliveryInfo deliveryInfo =
        new DeliveryInfo(DeliveryType.EMAIL,
            "example@example.org", null, null,
            20);
Calendar stopTime =
    Calendar.getInstance(TimeZone.getTimeZone("GMT"));
stopTime.add(Calendar.YEAR, 1);

// Package it up in a MetadataSubscription element
MetadataSubscription[] metadataSubscriptions = new
    MetadataSubscription[1];
metadataSubscriptions[0] =
        new MetadataSubscription(null, null, "Example Simple Subscription",
            providerGuid, datasetName, filterInfo, actionInfo, deliveryInfo,
           stopTime);

// Ask ECHO to create the subscription
String[] guids =
    subService.createSubscriptions(token, metadataSubscriptions);
```

If you provide a temporal condition in an AQL query for your subscription, you must leave ***NumberOfDays*** *empty in* ***MetadataFilterInfo****. Likewise, if you use* ***NumberOfDays****, you may not have a temporal constraint in your AQL.*

Each metadat subscription must have the following information:

Table 12: Metadata Subscription Information

Subscription Parameter	Description
Subscription Name	A unique name to describe this subscription. In ECHO 10.10, the name must be unique.
Provider GUID	The unique ID of the provider you wish to subscribe to. If you want to subscribe to all providers, you may use an asterisk (*) with constraints.
Dataset Name	The name of the dataset you wish to subscribe to or asterisk (*) to indicate all datasets from the selected provider(s).
Metadata Filter Info	The spatial and/or temporal constraint to use for the subscription to narrow the

Subscription Parameter	Description
	data to a specific geographic location or period(s) of time. The AQL query filter is used to specify an IIMS AQL condition when validating metadata updates specified in your subscription preferences. The temporal filter element is an integer that represents a specified number of days prior to today's date--that is, a span of days--that allows you to focus on data whose acquisition dates fall within that span. Note that you can only set the temporal filter either in the AQL TemporalCondition or in the NumberOfDays. It is an ERROR to set it in both.
Metadata Action Info	The information related to processing of the subscription. Like Query, you can limit the metadata fields returned by a subscription by specifying a list of MetadataAttributes.
Compression Type	The compression type to use on the metadata file. Note the subscription files delivered from ECHO are XML-formatted and highly compressible. It is recommended that you use a CompressionType of GZIP to conserve space and bandwidth.
Subscription Update Type	The type of metadata to subscribe to: • ALL_COLLECTIONS: You will receive all updated collection metadata. • COLLECTIONS_ONLY: You will receive all updated collection metadata from within your specified collection. • GRANULES_ONLY: You will receive all updated granule metadata from within your specified collection. • BOTH: You will receive both the updated collection metadata and the updated granule metadata from within your specified collection.
Delivery Info	The way in which metadata should be delivered from the subscription: EMAIL or FTPPUSH. If email is chosen, the DeliveryAddress should be of the format "username@domain". If FTP Push is chosen, the DeliveryAddress should also be of the format "username@ftp.domain". For FTP deliveries, the DeliveryFolder and Password fields are required. The Subscription Service has a governor that prevents delivery of metadata above a certain threshold. LimitSize is your specified maximum acceptable size (in megabytes) of the delivery file. The system calculates the size of the data file prior to delivery; if the size exceeds LimitSize, the file is not delivered.
StopTime	The time after which metadata should cease to be delivered.

10.6 Deleting a Subscription

To remove a subscription, call the **RemoveSubscriptions** operations with the GUIDs of the subscriptions to remove, as shown below.

Code Listing 62: Removing a Subscription

```
String[] subGuids = new String[] { "[subscription guid]" };
subService.removeSubscriptions(token, subGuids);
```

10.7 Listing Subscriptions

You can list the names and GUIDs of subscriptions using the **GetSubscriptionNames** and **GetSubscriptionNamesByState** operations.

Code Listing 63: Listing Subscriptions

```
subGuids = new String[] { "[subscription guid]" };
NameGuid[] allActiveNames =
    subService.getSubscriptionNames(token, null);

NameGuid[] specificActiveNames =
    subService.getSubscriptionNames(token, subGuids);

NameGuid[] allExpiredNames =
    subService.getSubscriptionNamesByState(token,
            SubscriptionState.EXPIRED);
```

Code Listing 64: Sample Granule Query Using Various Granule Conditions (Inventory)

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE query PUBLIC "-//ECHO CatalogService (v10)//EN"
"http://api.echo.nasa.gov/echo/dtd/IIMSAQLQueryLanguage.dtd">
<!--
Search for granules from the L70R or L70RWRS or GLCF_GRANULE_METADATA
datasets that have Browse data and were categorized as day granules.
-->
<query>
<for value="granules"/>
<dataCenterId>
  <list>
    <value>ORNL_DAAC</value>
  </list>
</dataCenterId>
<where>
  <granuleCondition>
    <browseOnly/>
  </granuleCondition>
  <granuleCondition>
    <cloudCover>
      <range lower="10" upper="20"/>
    </cloudCover>
  </granuleCondition>
  <granuleCondition>
    <dataSetId>
      <list>
        <value>'L70R'</value>
        <value>'L70RWRS'</value>
        <value>'GLCF_GRANULE_METADATA'</value>
      </list>
    </dataSetId>
  </granuleCondition>
  <granuleCondition>
    <dayNightFlag value="DAY"/>
    </granuleCondition>
  </where>
</query>
```

Code Listing 65: Sample Granule Query Using Spatial and Temporal Bounds (Inventory)

```
<?xml version="1.0" encoding="UTF-8"?>
```

```
<!DOCTYPE query PUBLIC "-//ECHO CatalogService (v10)//EN"
"http://api.echo.nasa.gov/echo/dtd/IIMSAQLQueryLanguage.dtd">
<!--
Search for granules the specified spatial region, and periodic temporal
extent
-->
<query>
<for value="granules"/>
<dataCenterId>
  <list>
    <value>ORNL_DAAC</value>
  </list>
</dataCenterId>
<where>
  <granuleCondition>
    <spatial operator="RELATE">
      <IIMSPolygon>
        <IIMSLRing>
          <IIMSPoint lon="-120" lat="-30" />
          <IIMSPoint lon="-100" lat="-60" />
          <IIMSPoint lon="-5" lat="-90" />
          <IIMSPoint lon="5" lat="85" />
          <IIMSPoint lon="-120" lat="30" />
          <IIMSPoint lon="-120" lat="-30" />
        </IIMSLRing>
        <IIMSLRing>
         <IIMSPoint lon="80" lat="20" />
         <IIMSPoint lon="80" lat="60" />
         <IIMSPoint lon="20" lat="60" />
         <IIMSPoint lon="20" lat="20" />
         <IIMSPoint lon="80" lat="20" />
        </IIMSLRing>
       </IIMSPolygon>
      </spatial>
    </granuleCondition>
  <granuleCondition>
    <temporal>
    <startDate><Date YYYY="1989" MM="01" DD="01"/></startDate>
    <stopDate><Date YYYY="1998" MM="12" DD="31"/></stopDate>
    <startDay value="1"/>
    <endDay value="300"/>
    </temporal>
  </granuleCondition>
  </where>
</query>
```

Code Listing 66: Sample Granule Query Using Sensor Name (Inventory)

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE query PUBLIC "-//ECHO CatalogService (v10)//EN"
"http://api.echo.nasa.gov/echo/dtd/IIMSAQLQueryLanguage.dtd">
<!--
Search for granules from ORNL_DAAC with source name SWIR or TIR
-->
<query>
```

```
<for value="granules"/>
<dataCenterId>
  <list><value>ORNL_DAAC</value></list>
</dataCenterId>
<where>
  <granuleCondition>
    <sensorName>
      <list>
        <value>'SWIR'</value>
          <value>'TIR'</value>
        </list>
    </sensorName>
  </granuleCondition>
  </where>
</query>
```

Code Listing 67: Sample Granule Query Using Temporal Constraints (Inventory)

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE query PUBLIC "-//ECHO CatalogService (v10)//EN"
"http://api.echo.nasa.gov/echo/dtd/IIMSAQLQueryLanguage.dtd">
<!--
Search for granules with temporal range: periodic range between Jan 1, 1990
and Dec. 31 1998 from the 1st to the 300th day
of each year.
-->
<query>
  <for value="granules"/>
  <dataCenterId>
    <list>
      <value>ORNL_DAAC</value>
    </list>
  </dataCenterId>
  <where>
    <granuleCondition>
      <temporal>
        <startDate>
          <Date YYYY="1990" MM="01" DD="01"/>
        </startDate>
        <stopDate><Date YYYY="1998" MM="12" DD="31"/></stopDate>
        <startDay value="1"/>
        <endDay value="300"/>
      </temporal>
    </granuleCondition>
  </where>
</query>
```

Code Listing 68: Sample Granule Query Using Additional Provider Specific Attributes (Inventory)

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE query PUBLIC "-//ECHO CatalogService (v10)//EN"
"http://api.echo.nasa.gov/echo/dtd/IIMSAQLQueryLanguage.dtd">
<query>
  <for value="granules"/>
  <dataCenterId>
    <value>ORNL_DAAC</value>
  </dataCenterId>
  <where>
    <granuleCondition>
      <additionalAttributes>
   <additionalAttribute>
        <additionalAttributeName>'COORDINATE_UNITS_NAME'</
additionalAttributeName>
        < additionalAttributeValue><value>'METERS'</value></
additionalAttributeValue>
   <additionalAttribute>
    </additionalAttributes>
    </granuleCondition>
  </where>
</query>
```

Code Listing 69: Sample Granule Query Using Additional Provider Specific Attributes with Complex Values (Inventory)

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE query PUBLIC "-//ECHO CatalogService (v10)//EN"
"http://api.echo.nasa.gov/echo/dtd/IIMSAQLQueryLanguage.dtd">
<query>
<for value="granules"/>
  <dataCenterId>
    <value>ORNL_DAAC</value>
  </dataCenterId>
  <where>
    <granuleCondition>
    <additionalAttributes>
      <additionalAttribute>
      <additionalAttributeName>'SAMPLE_DATE'</ additionalAttributeName>
      <additionalAttributeValue>
        <dateRange>
          <startDate>
            <Date YYYY="2000" MM="05" DD="12"/>
          </startDate>
          <stopDate>
            <Date YYYY="2000" MM="10" DD="12"/>
          </stopDate>
       </dateRange>
     </additionalAttributeValue>
   </additionalAttribute>
   </additionalAttributes>
   </granuleCondition>
  </where>
</query>
```

Event Notification Service for information about using XPath for filtering, etc..

D.1 Format

The general format for the URI is <**echoItemType**>://<**echoHost**>/<**echoItemId**>[/**xpath**]

g. **echoItemType** := granule (or collection)—This is the syntax to indicate whether the URI is pointing to a granule or collections metadata.

h. **echoHost** is the address of the ECHO server the metadata is on. This should be left blank for now, as this feature is not currently supported.

i. **echoItemId** is the item ID of the of the granule or collection (for example, C14016455-PSATEST).

j. **xpath** is optional. It is an XPath statement that maps into the XML payload returned from a GetMetadata request using the echoItemId.

Here is an example in the correct format. Note that the echoHost is left blank.

collection:///C14016455-PSATEST/%2Fresults%2Fprovider%2Fresult%2FCollectionMetaData%2FECHOItemId%2Ftext%28%29

The XPath above is escaped to be put in the URI. The un-escaped format looks like: "/results/provider/result/CollectionMetaData/ECHOItemId/text()"

D.2 Behavior

The granule mapping URI will retrieve data from the XML metadata of a granule or collection. The behavior that appears depending upon the state of the XPath selection appears below.

Table 15. ECHO Path URI Behavior

XPath Selection	Granule	Collection
No XPath included	Returns the entire metadata XML	Returns the entire metadata XML
XPath selects multiple nodes	Returns XML fragment representing multiple nodes	Returns XML fragment representing multiple nodes
XPath selects a node with child nodes and attributes	Returns XML fragment representing node and child nodes	Returns XML fragment representing node and child nodes
XPath selects a node with a single value	Returns single value	Returns single value

APPENDIX E. ECHO ERROR HANDLING

The ECHO 10.10 Web Service API has advanced error-reporting capabilities. There are 12 types of faults reported by ECHO. They are:

a. **AuthorizationFault** – Reported by ECHO when a user is not authorized to invoke an operation

b. **DataSizeLimitFault** – Reported by ECHO to indicate that the data size limit has been exceeded

c. **DuplicateIdFault** – Reported by ECHO to indicate that an entity with the same ID exists in ECHO already

d. **InternalFault** – Reported by ECHO when an internal error occurs

e. **InvalidArgumentFault** – Reported to indicate that one or more arguments passed were invalid

f. **InvalidStateFault** – Reported to indicate that an action by the client would put an object in ECHO in an invalid state

g. **InvalidURLFault** – Reported to indicate invalid syntax in a URL or an element of the URL that does not exist

h. **ItemNotFoundFault** – Reported when the client attempts to access one or more objects that do not exist

i. **ParseFault** – Reported to indicate that some value could not be parsed

j. **RemovalFault** - Reported to indicate an error that has occurred during the removal of an object from ECHO

k. **UnsupportedFeatureFault** - Reported to indicated that a feature was selected that is not supported

l. **ValidationFault** - Reported to indicate that an object in or passed to ECHO is not valid

All the above fault types extend the basic **EchoFault** type. An **ECHOFault** is reported by ECHO when an error occurred during the invocation of an ECHO operation

All faults will include an **ErrorCode**, **SystemMessage**, **and Timestamp** of when the error occurred and an **ErrorInstanceId**. An **EchoFault** may also have an **OpsMessage** (message specified by ECHO Operations).

Error codes are strings that uniquely identify an error case in ECHO. Some error codes are reused, such as when a required parameter to an operation was not provided. ECHO Operations may associate different messages with specific error codes. If ECHO Operations has a message configured for an error code, then that message will be returned with the **EchoFault** in the **OpsMessage** element.

In most instances, receiving a fault from ECHO occurs by catching an **EchoFault** and displaying the Ops Message, System Message, and Error Instance ID to the user.

InternalFaults capture errors that are internal to ECHO, such as when ECHO cannot talk to the metadata catalog or when an order attempts to transition to an invalid state. There is nothing a client can do to recover from an **InternalFault** except to report any information provided with the error to ECHO Operations.

Code Listing 72: Catching Exceptions from ECHO

```
try
{
  // Create authentication service
  AuthenticationServiceLocator authServiceLocator =
      new AuthenticationServiceLocator();
  AuthenticationServicePort authenticationService =
      authServiceLocator.getAuthenticationServicePort();

  ClientInformation clientInfo =
      new ClientInformation();
  clientInfo.setClientId("A Client");
  clientInfo.setUserIpAddress("192.168.1.1");
```

```
      // Call login with jdoe as username, mypass as password,
      // and client information
      authenticationService.login("jdoe", "mypass",
          clientInfo, null, null);
    }
    catch (EchoFault e)
    {
      // This exception was likely caused by user input.
      String message = "Could not login to ECHO:";

      if (e.getOpsMessage() != null
          && e.getOpsMessage().length() > 0)
      {
        message += "\nOps Message : " + e.getOpsMessage();
      }
      message +=
          "\nMessage: " + e.getSystemMessage()
              + "\nError Instance Id: "
              + e.getErrorInstanceId();
      System.out.println(message);
    }
    catch (RemoteException e)
    {
      // ECHO could not be reached.
      System.out
          .println("Could not communicate with ECHO :"
              + e.toString());
    }
    catch (ServiceException e)
    {
      // An error occured while creating the service.
      System.out.println("Could not create ECHO Service :"
          + e.toString());
    }
```

APPENDIX F. RESULTS DTDS

F.1 ECHO Collection Results DTD

The ECHO Collection Results DTD is located at the following link: ECHO Collection Results DTD

F.2 ECHO Granule Results DTD

The ECHO Granule Results DTD is located at the following link: ECHO Granule Results DTD

APPENDIX G. BEST PRACTICES FOR QUERIES

The following tips and other recommended practices will improve the efficiency of queries.

G.1 Best Practices for Faster Queries

- Limiting the end user choices will lead the user down a logical path. This will promote efficiency by limiting the choice to those applicable to the user's needs.
- Search for collections first and limit the collection search spatially or temporally and by data center. Limiting the collection will result in a narrower search and a smaller, more focused result set.
- Queries are optimized to return as soon as the requested iterator size is found. Therefore, to do a check for the existence of data, use a small iterator size such as 1 rather than a HITS query.
- The result type HITS requires the query to be executed and the entire result set identified and counted. Use this result type extremely sparingly.
- Use the MetadataAttributes to return only the necessary attributes when presenting data. ECHO defaults to all attributes, which will take longer to return and display.
- Request only what the user would see in the first few pages. For example, if the client only supports displaying 10 pages of 10 items, use an iterator size of 100. The client may want to pre-fetch the next page of results while the user is examining the first page.
- The user of the value element will be more efficient than the use of the range element in general.

G.2 Efficient Spatial Queries

- If you are querying a single Data Partner, name the Data Partner in the query.
- If you are querying a single collection, include the name of the collection in the query.
- Queries for smaller spatial regions return faster than queries for broader regions.
- Queries for spatial regions with fewer points return faster results than queries with more points.

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